TOPICS OF THE MONTH

Science out of tune

SCIENTISTS and professional societies in the U.S.A. have been urging the setting up of a Department of Science and Technology within the U.S. Government, but have not so far succeeded in convincing the Government that this is a desirable or practicable objective at present, although the idea is still being investigated. In Britain, where there is already a Department of Scientific and Industrial Research (much reshuffled of late), there is also dissatisfaction about the part played by the Government in making sure that scientific resources are used in the best interests of the nation, and here the call is now for a 'Minister of Science.' But the Government here has not shown itself any more favourable to such a suggestion than the U.S. Government has to a central U.S. scientific organisation.

At the annual dinner of the Institution of Chemical Engineers, held in London recently, the chief guest was Lord Hailsham, Lord President of the Council, whose comments on the relationship between Government and science were listened to with interest, if not with pleasure, by those who are dissatisfied with the present arrangement. While agreeing that, on the whole, the role played by the Government in scientific matters should have more consideration than it gets, he did not feel that there could ever be, in a strict sense, a Ministry of Science. He questioned the wisdom of thinking of science as a single subject, and pointed out that science was bound up with education, with industry and with government, and could not be abstracted from them. He felt it would never be enough to have a single Minister charged with the responsibility for the whole scientific field. What was wanted, he said, was a new attitude on the part of the nation, the Government, industry and trade unions. Industry should be determined at every level to maintain its influence in its proper field of applied science and technical education both by finance and by active participation both in its own and even in Government-sponsored bodies, and this influence should be felt in the formation of policy and the allocation of scientific manpower.

In brief, Lord Hailsham felt that scientific policy can best be seen as a partnership in which Government, teaching bodies, research scientists and industry all have important and inter-related roles.

We do not ourselves feel that these observations in any way contribute towards a solution to the problem, for partnerships are all very well, but everybody knows what happens in a partnership where partners disagree on what is to be done and there is no strong overruling hand. Nor does the argument that 'scientific decisions should be in the hands of scientists rather than politicians' hold water, for there has been no suggestion that scientific decisions should be placed otherwise; only that a strong, guiding organisation for science should be formed. The heart of the problem lies in whether this is entirely a matter for the Government, with the implication that more Government funds should be allocated to scientific research and organisation, or whether industry should take the lead in putting the country's scientific programme to rights. And here industry might well ponder on the thought that 'he who pays the piper calls the tune,' and if this or any other Government pays the piper, there is no guarantee that he will play the tune industry wants to hear.

Tit for tat

SOME time ago a story appeared in the newspapers about a farmer who, enraged by the litter left on his land by a party of picnickers, took unusual pains to return it to its rightful owners. He found out the address of the family responsible, bundled the litter into a sack, called at the house and emptied the sack all over the sitting-room carpet.

It is a sombre thought that, if this kind of poetic justice was brought to bear on industrial works which pollute rivers with effluent, it would mean that River Boards would install some fiendish sort of siphoning or pumping arrangement which would neatly recycle discharged waste so as to flood, say, the control room, the works canteen or even the works manager's office with it.

Fortunately, industry these days is generally too observant of the current laws against river pollution to warrant such drastic retaliation. However, it still has a lot to learn about efficient and economical treatment of effluents, while in many cases there are chemical problems still to be solved. As a contribution to a better understanding of this very wide field we include in this issue a number of articles and notes setting out some pointers to better planning and design of effluent plant. Some of the latest equipment for the processing of difficult wastes is described, while some new ideas for automatic control of continuously working treatment plants are also mentioned.

'Ins' and 'outs' of chemical plant

COMPLAINTS about failure to maintain promised delivery dates for chemical plant are mentioned in the annual report of the British Chemical Plant Manufacturers' Association, and it is recorded that the Association 'takes a very serious view of this matter.' The problem was investigated by the B.C.P.M.A. and the Association of British Chemical Manufacturers and this is expected to help ease the situation. It will be recalled that the necessity of maintaining delivery dates was stressed at the last annual dinner of the B.C.P.M.A. by both Mr. H. W.

Fender (chairman, B.C.P.M.A.) and Sir Miles Thomas, chairman of Monsanto Chemicals (see CHEMICAL & PROCESS ENGINEERING, 1958, **39** (12), 421).

The B.C.P.M.A. annual report notes a substantial increase in exports of chemical and allied plant, coming to a value of £14.96 million compared with £10.47 million in 1957. The largest group market for chemical and allied plant was again the Commonwealth which took 69% by quantity and 61% by value of total exports in 1958. Five per cent by quantity and 8% by value went to the six countries forming the European Economic Community. In the category 'gas and chemical machinery' the largest consignments, in order of importance, were to India, Australia, South Africa, Eastern Germany, Japan and Malta; the shipments to India accounted for 52% by value of the total.

Imports of chemical plant, which had risen sharply in 1957, fell off, the total quantity of 1,298 tons being close to the 1956 figure. Almost all these imports came from Europe; 37.5% by value came from Western Germany, and 68% from that country and the other five (Belgium, France, Italy, Luxembourg and the Netherlands) forming the European Economic Community. From the U.S.A. came 8.6%.

Keeping control under control

THE applications of electronic computers to problems of control and design, with the main emphasis on control, were discussed in papers presented at the symposium held in London last month, under the aegis of the British Conference on Automation and Computation, by the Institution of Chemical Engineers, the Society of Instrument Technology and the British Computer Society. It was an ambitious programme, and the title 'Instrumentation and Computation in Process Development and Plant Design' resulted in a wide variety of subjects being discussed including, for instance, the control of axial-flow compressors, plant and process cost estimation, the organisation of a computer-aided design department, a machine which adds to the safety of a gas-cooled nuclear reactor and (Russian) investigations into the cold-rolling process for the steel industry—as well as good, solid chemical engineering stuff relating to the design, control and optimisation of various types of plant and processes.

These papers certainly revealed some useful information about the applications of computers to industrial design and operational problems. But they also showed, as a whole, that the new control techniques are becoming very complex and are tending to slide beyond the reach of the ordinary engineer or designer. We are inclined to agree with the view expressed by Sir Harold Hartley, in his summing up at the end of the conference, that control engineering has become a subject in its own right which requires its own philosophy and disciplines. If this view is accepted, it means that some re-thinking must be done about the composition of design teams and the organisation of projects.

A giant in Norway

WE have recently commented in these columns on moves being made in New Zealand to establish industries based on hydro-electric power and producing calcium carbide and other chemicals. An example of what can be done with hydro-electric power, provided the minerals are available, is provided by the big Norwegian firm Norsk Hydro, which is producing yearly 1½ million tons of 40 different products worth more than 500 million kroner (20 kroner = £1). Most of the output consists of nitrate of lime and other nitrogenous products which the company is now making at the rate of 250,000 tons p.a. Production is by the ammonia method based on hydrogen as well as nitrogen. Hydrogen is obtained by the electrolysis of water and nitrogen by the fractional distillation of liquid air.

Norsk Hydro has about 50% of world production of nitrate of lime (15.5% N, produced at the rate of 1 million tons p.a.) and ranks among the four biggest exporters of nitrogenous fertilisers in Europe. It turns out annually 200,000 tons of complete fertiliser, 100,000 tons of ammonium nitrate limestone with 20.5% N, 70,000 tons of urea, 20,000 tons of concentrated nitric acid and 10,000 tons of nitrate of ammonia. Another notable Norsk Hydro commodity is heavy water, which the company started producing as early as 1934.

Among recent new ventures is the production of magnesium, with an output of 9,500 tons in 1958. Production is based on electricity, sea-water and dolomite. Already Norsk Hydro's magnesium plant is the biggest in Western Europe. Last year a carbide plant was started with a capacity of 30,000 tons p.a. Part of the output is used in Norsk Hydro's production of PVC and part is exported.

Norsk Hydro is today the biggest user of electric power in Norway, taking 4,500 million kwh. annually or about 18% of total Norwegian consumption, domestic as well as industrial. More than half is generated by the company's own power stations. Work is proceeding, too, on developing further sources of power, for, in spite of the increased cost of developing hydro-electric power which works out at about 1s./kwh., as compared with about 3d./kwh. for the company's older power stations, it is still a profitable proposition to develop new sources of supply.

Process operators see the light

AN idea that seems likely to catch on is the one they have in the Billingham Division of I.C.I. of giving process operators a proper course of training so that everything is not just a bewildering maze of pipes, vessels and valves to them, and so that they can go about their work happily confident in what they are doing.

Aim of this course is to teach the men the principles underlying the basic operations in chemical plant—filtration, absorption, distillation and so on—and to introduce them to typical pieces of equipment they will operate or see in use on the plant.

A feature of the instruction is that the men are not merely trained to do jobs which are peculiar to a particular works but are given a basic training which will be just as useful in the ammonia works as in the coke-oven plant or gypsum plant. Another very useful thing is that the importance of accuracy and legibility in making out record sheets is stressed.

The Billingham idea, which started with an experimental course in 1957, has aroused the interest of other I.C.I. divisions, while other firms in the chemical and allied industries have asked for information.

Standards for heat exchangers in U.S.A.?

STANDARDISATION of shell-and-tube heat exchangers is the aim of a new plan by the American Standards Association. If this is successful, savings of some $4 million p.a. could result for American chemical and allied industries as a result of quantity production of components and even complete exchangers; reduced engineering costs; simplified maintenance and wider re-use of exchangers; and faster availability of design information and equipment.

The plan was discussed in a recent issue of *Chemical & Engineering News*, according to which the U.S.A. will try to set up standards for shell-and-tube heat exchangers that may use plain or low-fin tubing, fixed tube sheet with or without a shell expansion joint, U-tube internal floating head, outside packed floating head, and kettle-type reboiler. The association will also review present standards, modify them where necessary to cover critical construction practices of interest to the chemical industry, and develop a line of standard units if it proves feasible.

It is also pointed out that among matters to be considered in modifying present standards are: the establishment of minimum depths of channels and bonnets, the provision of standards for design pressures above 600 p.s.i. and the setting of limits for application of design formulae, the extension of construction standards to cover clad materials, the establishment of uniform dimensions for body flanges, and standardisation of nameplate location and recorded data. The project arose out of a request by the Manufacturing Chemists' Association and will be sponsored by this association and the Tubular Exchanger Manufacturers' Association.

Bowler does a hat trick at Romford

THERE is probably nowhere, apart from the City of London, where bowler hats are more abundant than in the British gas industry. There they are in considerable evidence on the heads of executives and engineers, perhaps as a traditional symbol of authority. A useful one, too, for there is no place where it is harder to find the man you want than in the sprawling maze of retort houses, booster rooms, laboratories, gas holders and pipework that typifies the average gas works and, as the man you want is almost bound to wear a bowler hat, he is easily sighted from afar amongst the hatless or cloth-capped workers. The fact that the bowler hat provides useful protection for the head when ducking under pipework, retorts, coke hoppers, etc., might also have something to do with it.

These irrelevant, but not irreverent, thoughts occurred to us when, flanked on both sides by bowler hats, we attended the official inauguration of the new gas reforming plant at the Romford (Essex) works of the North Thames Gas Board by the Minister of Fuel and Power. But here there was no sprawling maze, and we did not have to duck, not even once, during our tour of the plant. This is because the layout of the plant makes it a model of neatness and cleanliness, adding to the atmosphere of quiet efficiency which pervades the whole scene. This is, in fact, the gas industry with a 'new look' engendered by the use of oil refinery gas instead of coal as the raw material.

We have made previous references to the Romford project and to the engineering and corrosion problems that had to be solved in catering for the transportation of rich gas from the Shell Haven and Coryton refineries, 17 miles away, through a 24-in. steel main. The first supplies of gas reached the Romford plant in May 1958 while already supplies of methane, carried across the Atlantic in the much-publicised tanker experiment, have been taken from Canvey Island and the first trial cargo of 2,000 tons has passed through the Romford reforming plant.

The catalytic reforming plant, which operates on the O.N.I.A.-G.E.G.I. principle (discussed by A. R. Myhill in CHEMICAL & PROCESS ENGINEERING, September 1958), has already achieved some impressive outputs. As recalled by Dr. J. Burns and Mr. E. R. Stuart in a paper presented to the Institution of Gas Engineers in Llandudno at the end of May, it was not possible in the early stages to predetermine precisely the outputs that could be obtained; a basic figure of 9 million cu.ft./day at the middle range of calorific values was considered possible. The outputs obtained in this range have, however, risen to 13 million cu.ft./day of 500 B.Th.U./cu.ft. gas, and this extra provides welcome increased capacity. The outputs obtainable at the lower range of calorific value, amounting to 15 million cu.ft./day, augur well for the outputs likely to be obtained on the reformation of methane.

The gas-making plant consists essentially of four identical units, each comprising a preheater, a reactor, a waste-heat boiler and a wash-box. The preheater

is a mild-steel, refractory-lined, vertical cylindrical vessel of 12 ft. i.d. At the foot of the vessel is built the combustion chamber equipped with the primary burner (of Urquhart design) and a small pilot-burner with an automatic flame-failure shut-down device. A set of refractory arches across the preheater supports a section of chequer brick packing, on top of which a layer of sole bricks carries the first catalyst bed of 12 in. depth.

The reactor, too, is of mild steel construction lined with refractories, and is of 17 ft. i.d. The inlet at the top, leading from the preheater, is designed to promote even gas distribution across the catalyst bed, which is a layer 18 in. deep supported by sole bricks on arches across the vessel. There is a total of 17½ tons of catalyst in each of the four units, one-quarter of this being in the preheater and three-quarters in the reactor.

Waste gases pass out of the main stack valve during the heating phase and enter a tubular heat interchanger before continuing to atmosphere *via* a single common stack 125 ft. high. There are two heat interchangers, each associated with a pair of gas-making units, and they serve to preheat the air blast to their respective units to temperatures of about 130°C.

The gas outlet main from the four wash-boxes leads to three washer-scrubbers packed with wooden grids, where the gas is cooled by direct contact with water. Cooled gas passes from the scrubbers to the three boosters, which are of the steam turbine-driven centrifugal type.

There is an impressive control room attached to the plant, which is fully instrumented; although there is no final operational control by the instruments themselves, the complete automatic operation of valves and the automatic control of safe operation allows the plant to run with minimum labour. An elaborate system of audible and visual alarms ensures plant safety.

According to Mr. M. Milne-Watson, chairman of the North Thames Gas Board, the capital cost of the new operation works out at less than 1d./therm compared with 3d./therm for a conventional coal-gas plant. It looks as though at Romford the gas industry has pulled something pretty good out of its bowler hat.

Fluid displacement in porous masses

SOME ideas on multiphase flow through porous masses which came up at a recent two-day meeting at the Imperial College of Science and Technology, London, under the chairmanship of Prof. P. V. Danckwerts, seem to have more relevance to the practical problems of industry than might be thought from a cursory examination of this somewhat weighty discussion, which had particular reference to the displacement of one fluid by another and to fluid mixing.

Thus the long-term economy of the oil-production industry might well depend on its ability to find efficient means of recovering oil from difficult underground formations. Mr. C. van der Poel of the Royal/Dutch Shell Co. spoke about the instability of immiscible fluids and its significance in oil recovery by adding considerations of surface-tension effects and scale. He showed how experiments have been done on water and gas drive recovery in a two-dimensional flow model.

Again, Dr. W. B. Dobie, of the Alkali Division of I.C.I. Ltd., applied gas-liquid displacement flow theories based on the Kozeny-Carmen model to the problem of dewatering filter cakes. Gas-liquid displacement flow, and particularly the role of surface tension for liquid in static equilibrium in regular assemblages of spheres, was discussed by Prof. D. M. Newitt (Imperial College). Dr. P. Eisenklam of the same department dealt with the fluid kinetics of steady gas-liquid flow as it relates to intra-pore gas evolution from supersaturated liquids, to the flow and heat transfer to boiling liquids, and in general to flow in the turbulent regime.

Transverse and longitudinal mixing of two liquids was discussed by Dr. J. Hiby of the Technical University, Aachen. He compared results covering molecular and turbulent diffusion on the basis of a Peclet: Reynolds number correlation.

A little off the track of the main subject of this meeting, but none the less interesting, were the comments of Dr. C. van Heerden, of the central laboratory of the Dutch State Mines, on surface diffusion for the flow of condensable vapours. He showed that the Knudsen diffusion coefficient is applicable on a much wider range than hitherto accepted, and worked out numerical corrections over a range of ratios of mean free path of molecule to radius of capillary.

Elastomers laboratory

REFLECTING perhaps the increasing interest of American manufacturers in European markets, with greater European economic integration in sight, the Du Pont Co. (United Kingdom) Ltd., subsidiary of E. I. du Pont de Nemours & Co., have opened a new laboratory for development work on neoprene and other synthetic rubbers and chemicals at Hemel Hempstead, Herts., England.

This laboratory, to be staffed entirely by British graduates and technicians, is the first permanent facility to be completed by Du Pont in Europe, with the Du Pont neoprene plant nearing completion in Londonderry, Northern Ireland.

Equipment includes a high-pressure wire vulcanising unit with a chamber operating at steam pressures of 100 to 275 p.s.i. and a water chamber for cooling at the same pressures. The area for the processing of fluid elastomers is equipped with an ultrasonic homogeniser and a high-speed ball mill which processes materials in one-tenth the time required by conventional methods.

An extremely accurate and complex electronic load-measuring tester which can be used to measure virtually any of the physical properties of rubber operates from –70 to 550°F. A weatherometer, developed in Germany, can duplicate almost any type of condition from intermittent rain and high humidity to dry or humid sunshine.

EFFLUENTS

A special 'CPE' feature on: effluent plant planning and design; chemical and biological treatment; waste recovery; automatic control; etc.

Planning for Effluent Treatment

By R. F. Stewart, M.C., A.R.T.C., F.R.I.C., M.I.Chem.E., **and C. J. Smith,** M.Sc., A.R.I.C.
(*Dorr-Oliver Co. Ltd.*)

This article considers the chief factors to be taken into account in the planning and design of plant for the treatment of effluents and discusses some typical problems encountered in the chemical, paper, sugar, metallurgical and other industries.

EFFLUENTS from chemical plants are extremely varied and no standard plant can be devised for their treatment. Generally, an 'effluent' is, in fact if not in theory, made up of anything that can be put down the drain. This can and does vary from a controlled 'bleed' or waste discharge from a continuous process (which might form the flow basis) to the sudden and uncontrolled dumping of process materials due to mishap or process change. Within such wide limits, there are essentially two variables: rate of flow and chemical/physical quality.

Adequate raw effluent collection and buffer storage capacity is, therefore, a prerequisite and essential part of efficient treatment. In fact, a recent investigation of waste-discharge conditions in a colour (pigment) works, comprising some 26 separate flows, has shown that after provision of adequate collection and mixing equipment little more was needed since the constituent chemical flows were nearly in balance. Collection and buffer storage is usually at or below ground level owing to the downward run of the drains, and provides a convenient point from which to pump to subsequent treatment at a nearly constant flow rate, thereafter using gravity flow through the plant, ultimately to sewer or watercourse, or ideally for return for re-use. The aim should be simple control, automatic where appropriate, with minimum labour requirement. A higher first cost may be more than compensated by low running cost.

Siting of the treatment plant in relation to operating units is important, since it may be possible to economise on labour and even combine supervision with normal production duties.

After efficient 'housekeeping' to reduce the number and volume of waste discharges to a minimum, the recovery of materials and/or water must receive attention. Many plants loosely termed 'effluent treatment' are indeed giving a useful return on capital by such recovery. Examples are oil and fats from sewage, lube oils from harbours and refineries, blast-furnace flue dust from gas-washing water, silver salts from photographic processes, and, perhaps most widely of all, paper fibres from paper machine 'back-water.'

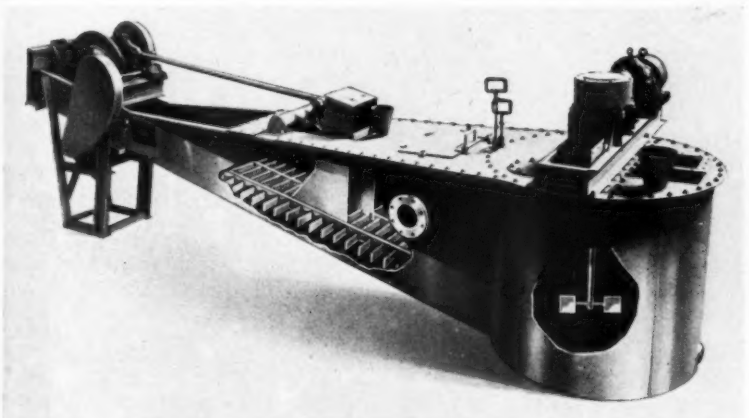


Fig. 1. A 'Dorrco' slaker, with cut-away portions showing impeller-type mixer in the slaking compartment and reciprocating classifier rakes in the classification section. Two submerged ports, controlled externally, allow passage of slurry into the classifier from the slaking compartment.

Removal of solids

In the majority of plants the removal of solids suspended in liquor is involved at some stage, as in the examples above, or as again in the removal of soil resulting from the fluming of beets in the sugar industry. In many plants neutralisation of an acid effluent by milk of lime is required, with resultant production of a precipitate, most frequently calcium sulphate. In such plants, the preparation of an essentially grit-free milk of lime is called for and equipment for the continuous slaking of lime is part of the treatment plant.

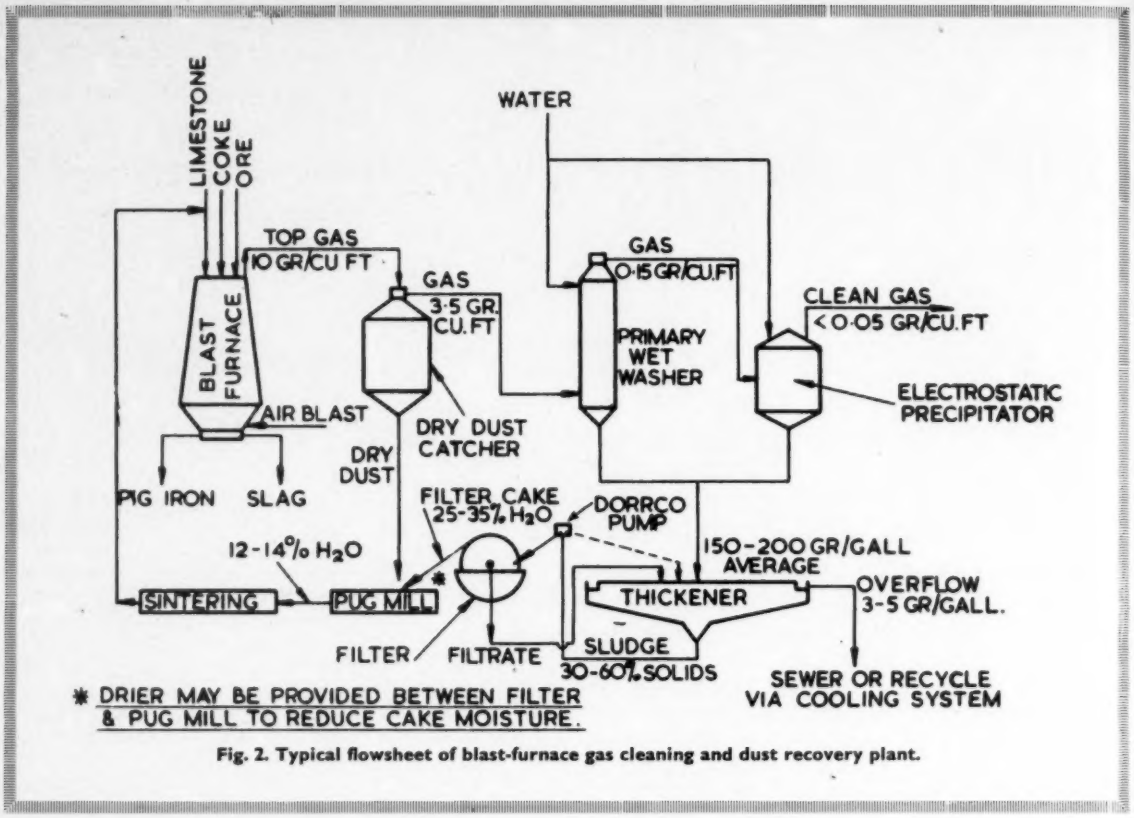


Fig. 2. Typical flowsheet of blast-furnace gas cleaning and dust recovery plant.

The grade of lime, in particular the degree of burning, should be carefully selected so as not only to get good reaction, but also to produce a well-settling precipitate. A continuous lime slaker is shown in Fig. 1.

It is important to produce a degritted milk of lime, otherwise sand settles in pipelines, wears pumps and chokes valves.

For the removal of sand and small stones (present in all commercial limes), a classifier or a hydraulic cyclone is used rather than screens which wear rapidly and become clogged by carbonated lime. The dose of milk of lime is conveniently automatically controlled by a *p*H instrument, and care is required in the layout to avoid the effect of 'hunting.'

Acid neutralisation

In the neutralisation of sulphuric acid, it is important so to conduct the reaction that a well-formed gypsum crystal is produced and the recirculation of precipitate to encourage crystal growth is a useful 'dodge.' Likewise, care has to be taken to allow sufficient reaction/retention time to relieve the system of gypsum supersaturation—the latter phenomenon being a well-known propensity of the substance. In particular, the type of gypsum produced is important if the sludge has to be filtered and disposed of by cartage. Filter cakes predominantly of gypsum will vary from friable (dry) to thixotropic (wet) depending on a number of factors, the chief of which are crystal (needle) length (see above) and the 'packing' of these crystals in the cake, the latter in turn depending upon the feed-slurry dilution.

The sludge problem

Sludge disposal from effluent treatment plants is becoming, in urban areas, a most serious problem, not less important, in fact, than the original problem of producing a clarified liquor acceptable to river or sewer. Careful thought must be given to such factors in choosing the method of treatment; indeed, this will in most cases decide what chemicals are to be used (*e.g.* for acid neutralisation). Whilst lime is a cheap and widely distributed reagent, usually found within easy reach of any works, it produces sludge, whereas soda ash, more costly, produces a soluble reaction product with, say, sulphuric acid. Similarly, the use of sulphur dioxide is replacing copperas ($FeSO_4$) as the reducing agent for hexavalent to trivalent chromium in plating-waste treatment, although the latter is obtainable at almost 'transport' cost.

Dust, soil and sand removal

A flow diagram of a process for recovering blast-furnace dust is shown in Fig. 2. Rather large flows have to be handled, frequently 5,000 gal./min. or so, and important design points are adequate slope of launders and dispersal of kinetic energy of flow on entering the thickener or *Clariflocculator* (Fig. 3). Thickened slurry is frequently filtered on rotary vacuum filters (Fig. 4) and, after admixture with dust from the dry dust catchers and sintering, is suitable for returning to the furnace. Adequate pre-thickening is essential to good filtration. Too thin a sludge encourages the passage of fine solids through the cloth and the production of thin cakes that are very difficult to discharge from the filters.

The water recovered from the

thickeners is recirculated, but normally a portion must be bled off to prevent excessive building up of solubles. In beet-sugar factories, taken in total, some 10,000 to 15,000 tons of soil adheres to the beets and is removed from the land per day—a rather serious case of soil denudation. Along with the fine soil and sand are stones, and a treatment plant must include stone traps, sand catchers, and screens to remove vegetable trash before the water is treated in thickeners. A convenient form of sand trap is the *Dorrco* sand washer as used for washing river sands and fine ballast (see Fig. 5).

The sand is removed from the flow so as not to block the thickeners, and is later re-mixed with the fine mud, the mixture being pumped away to a catchment pond. Unfortunately, the treatment to a large extent denatures the soil and the pond contains very slimy mud and sand at or near the entry point. The recovered water is kept in circulation for washing and fluming incoming beets.

Modern developments have called for the design of plants to treat radioactive effluent, as at the Atomic Energy Research Establishment, Harwell, which plant has been described elsewhere. Such plants involve the use of precipitates to carry down the radioactive particles and it is essential to have very skilled laboratory control, with storage of treated water to allow testing before discharge to a stream.

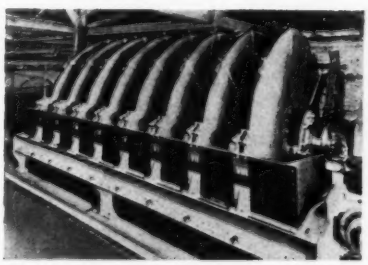


Fig. 4. Continous rotary vacuum filter with co-axial discs built up from sectors individually cloth-covered on both sides.

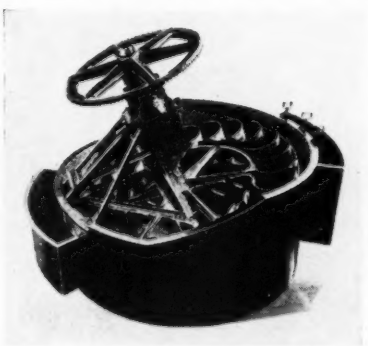


Fig. 5. 'Dorrco' sand washer, showing the semi-circular scoops which travel round on the annular ring fitted inside the washing compartment.

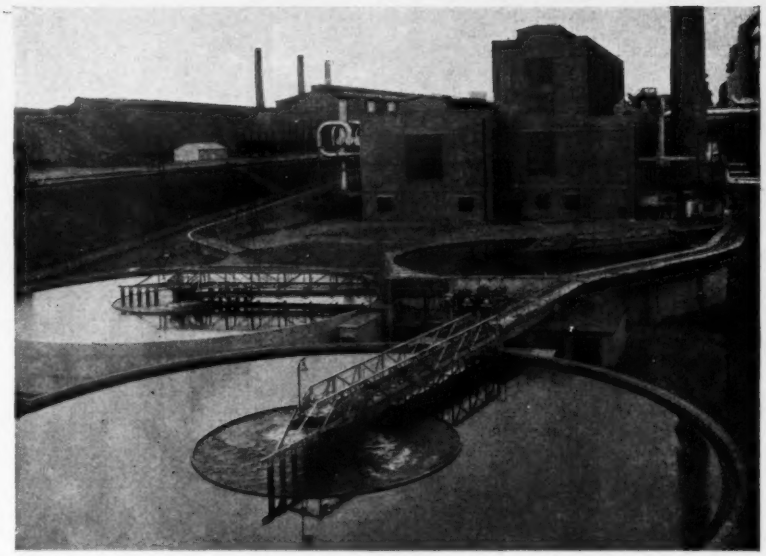


Fig. 3. 'Clariflocculators' for dealing with blast-furnace dust at the Scunthorpe, Lincs., works of the Appleby-Frodingham Steel Co.

Paper industry effluents

The treatment of effluent from paper mills is another large field and simple sedimentation with or without chemical dosage is usually adequate for less putrefactive disharges. The older flocculating agents such as starch, glue, lime, alum, etc., are to some extent being replaced by newer materials such as activated silica and polyelectrolytes. Although somewhat specific in effect, and expensive, when effective the dose is to be measured in 1 or 2 p.p.m. rather than up to 30 to 100 p.p.m. for the older agents. Sedimentation, particularly with chemical flocculation, will in some cases, reduce B.O.D. (Biochemical Oxygen Demand) by up to 50%; some reduction is always obtained and reduction is all the greater where initial B.O.D. is high. Residual removal to satisfy the usual water-course standard of 30 p.p.m. is, for chemical or 'industrial' effluents, always difficult and costly. Considerable attention is being given to these problems and some progress made in adapting the 'activated sludge' methods of sewage disposal. The treatment of effluents from rag boiling, as in the case of special banknote papers, presents a most difficult problem, and probably the expensive solution of incineration is the only sure answer.

Planning of chemical effluent plants

Aside from relatively standard wastes, such as beet-flume water, blast-furnace dust, and some paper mill effluents the problem of dealing with effluent from a chemical factory requires investigation on site, as the components are frequently numerous and vary both in quality and quantity over short periods. The components may have to be separated into groups and adequate buffer storage provided, as suggested above.

The effluent plant should be taken into account in the planning of production and not left until after operations have commenced, by which time no space is available and River Boards are making trouble. A plant planned ahead has, of course, to be designed on 'best guesses' and, therefore, has to be a versatile unit. It has been known for an acid effluent to be forecast, when in fact the effluent turned out to be on the alkaline side, although this is an extreme case.

Finally, it can be stated that the trend in the chemical industry is to use the services of contractors experienced in this field and to get away from the old static settling ponds, so long the accepted type of treatment and involving manual cleaning-out. An effluent plant properly serviced and maintained can be just as much a showpiece as any other unit in the works, and the industry is now giving such plants much more careful thought from both the design and maintenance aspects.

Automatic Control of Effluent Neutralisation

By G. Eifert, Dipl.-Ing.
(J. C. Eckardt A.G., Germany)

Effluents from chemical plants must be rendered innocuous before discharge, but pH and concentrations of constituents may vary considerably so that types and quantities of neutralisers must be continually adjusted. In a German plant, the problem has been solved by automatic control. At present, only acid is neutralised by the system but its future extension to basic or rapidly alternating conditions is discusssed.

IN a German chemical plant of medium size with a diverse manufacturing programme, the composition of the effluents can vary within wide limits. On the whole, their present character is acid, the *p*H value being some 4.5±1.5. There are small quantities of oils and solvents which are removed in a separator before the remainder is automatically neutralised by means of dolomite suspension.

The control system is designed to regulate the composition of dolomite suspension and to add the required amounts of it.

Neutraliser preparation

Research showed that dolomite is the most economical neutraliser for effluent acid. For instance, in the plant discussed here, neutralisation with lime would produce twice as much sludge residue; and if NaOH were used, the capital costs would be considerably greater than with dolomite.

The latter is a mixture of magnesium and calcium carbonates which combine with the acids in the effluent water. The reaction increases exponentially with time so that it only needs starting off in a mixer. The effluent-dolomite mixture then arrives in a settling tank with 6 to 6.3 *p*H. The tank volume is calculated to provide sufficient time for all remaining free acids to be neutralised before the mixture is let out into the sewers.

During this reaction, particularly inside the mixer, CO_2 is given off and the hot gas is led out through a chimney.

For the neutralisation reaction a supply of suspension of constant proportions is required. The dolomite powder is stored in a silo-type vessel and transferred into a screw feed conveyor by means of a star wheel and thence into a mixer where it is stirred into water.

As the demand for the suspension varies, the water supply to the mixer is directly controlled by a float valve so that a constant level of liquid is maintained. This makes it possible to dispense with direct control of the dolomite powder feed and, instead, use the power required by the mixer as an indication of the consistency of the suspension.

The control loop

From each plant section the effluents are collected in settling pits. As soon as a preset level is exceeded in any pit, an acid resisting pump empties it into the central neutralisation plant where the *p*H value is reduced to about 7. However, in order to shorten the process lag, the value after leaving the settling tank is recorded only as an end-point check on the overall performance and for alarm purposes. *p*H measurement for control purposes is made in the feeder to the settling tank.

The *p*H probe is connected to a pneumatic controller with moving-coil measuring system the set pressure of which acts on the valve which controls the feed of dolomite suspension to the funnel agitator. It will be seen from the flow diagram in Fig. 1, that even this shorter loop includes a considerable lag. This is made up of genuine dead-time (while the neutraliser flows from its feed valve through the mixer to the instrument) and the response time of the *p*H electrode itself is added to this total.

For this reason, a 3-term controller is required. The input variables to the control loop are quantity and composition of the effluents. Two other loops ensure that the composition of the dolomite suspension remains approximately constant, the float valve keeping the liquid level

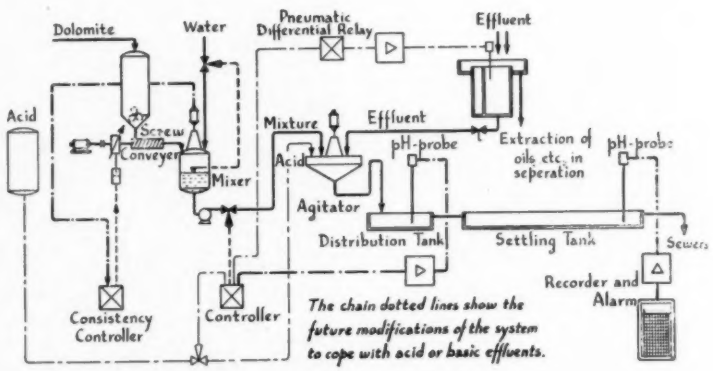


Fig. 1. Flow diagram of disposal plant and future extension.

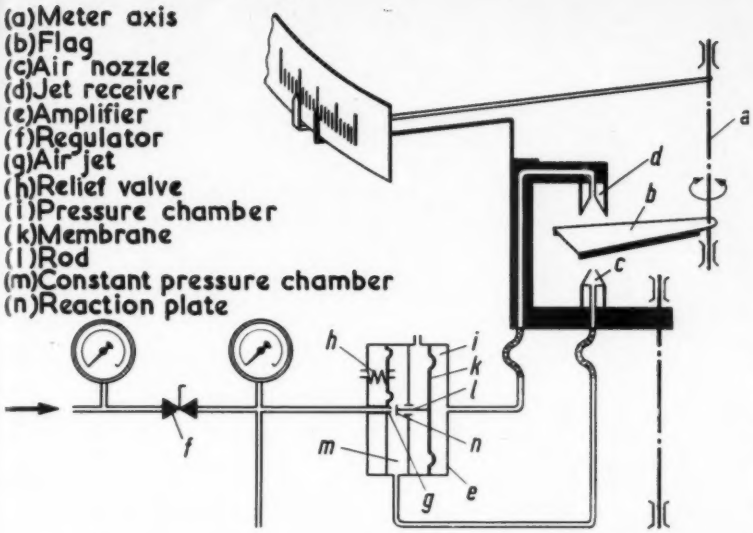


Fig. 2. This indicator-controller depends on a flag on the pointer shaft interrupting an air jet and is used for all variables.

constant inside the mixer. The input current to the motor can be taken to represent consistency of the suspension. A pneumatic actuating cylinder is controlled by a pneumatic instrument according to current measured. This, in turn, adjusts a continuously variable mechanical transmission between the dolomite feeder and its motor. Here, again, a 3-term controller is required, because some dead time during the travel of the powder through the conveyor is unavoidable.

The type of instrument used throughout the plant wherever direct acting proportional controllers are not feasible, transmits pneumatic signals. A jet of air is interrupted by a flag on the meter when the set value has been reached, which has the advantage that the metering side remains quite independent of the transmitter and no special pneumatic transducer is required in the case of electrical measurement. This is shown in Fig. 2.

In operation it was found that, at a certain r.p.m. of the mixer, there arose periodic fluctuation in the power supply to its motor. Its makers confirmed that this was the result of periodic slipping of fluid eddies from the mixer blades and it was necessary to avoid this resonant speed.

Starting and stopping

As soon as one of the effluent pits is full, its pump starts up to empty it and continues until nearly empty. The neutralisation plant is in almost continuous operation. But it would be quite feasible to interlock the star wheel, screw conveyor and mixer, so that they all start, as soon as one of the pumps starts. For the present, these motors are started through a pressure switch built into the pneumatic transmission line from the *p*H controller. This is possible because, at present, the effluents are predominantly acid, so that the arrival of un-neutralised fluid at the controller electrode causes a rise in the transmitted pressure which, in turn, causes the switch to start the motors for the dolomite supply, whenever neutralisation is required.

Stopping is effected through a timer with adjustable delay, so that the dolomite supply continues for a period, even after only neutralised effluent is sensed.

This type of control circuit, however, is permissible only so long as the effluents remain predominantly acid.

Further development

As further process plant construction will result in the possibility of predominantly basic effluent, it will become necessary to use a different starting system, depending on the pumps, rather than the *p*H. By then, the system will have to be modified so that the *p*H instrument controls two valves, one for addition of dolomite, the other for adding acid. Transmission pressure being inversely proportional to *p*H, one valve will be operated by direct, the other by reverse pressure.

Conditions may arise in which the effluent could, at any time, be either acid or alkaline. In that case it will, presumably, be necessary to reduce instability by taking the *p*H value at the inlet of the agitator and using it as preliminary input variable to the controller, diminishing in effect as the mixture of the changed composition reaches the main probe. A differential pressure relay may be used for the temporary resetting of the controller during this period.

Cascade control

For systems which are concerned with batch processes, the use of cascade temperature controls are usually recommended. As the time functions of *p*H control can be considered similar, in principle, to those of temperature, it should be considered whether, in the plant described here, a cascade system would not result in improved control. The principle of such an arrangement would be to rectify, by means of local control loops with short time constants, as many as possible of the causes of the ultimate deviation from desired values. Only very slow disturbances would then be corrected by means of the sluggish main control loop.

In the case under discussion, the following factors could, theoretically, result in *p*H variations at the probe: quantity and *p*H of the effluent, quantity and composition of the neutraliser, and changes in reaction time and intensity with changed plant conditions.

But the pumps are arranged to keep the supply of effluent approximately constant, at least within a single shift. The composition of the dolomite suspension is also kept approximately constant, as described. Its quantity depends on the pumps and the *p*H controller; unforeseen changes in pressure are not to be expected because the mixer level is controlled and an overflow is provided before the agitator is reached. Changes in the reaction itself will occur very slowly, if at all.

Thus, only *p*H value of the effluent remains as the main input variable and a cascade control would be confined to sub-dividing the change throughout the plant, the first probe being placed immediately after the funnel agitator, the last one, controlling the overall loop, in the outlet from the settling tank to the sewers.

Experience so far seems to indicate that only the shorter of these loops is required and such resetting of the controller as is necessary can be done by hand.

Modern Methods of Waste Treatment

By P. B. Smith and C. H. Dykes
(*Norris Brothers Ltd., Consulting Engineers*)

The authors discuss some effluent problems in the metal-finishing, plating and allied industries and outline some methods of treatment. Two very different examples of waste recovery are also given.

THE sources of trade wastes that demand specialist treatment are many and include, amongst others, discharges from food and canning factories, tanneries, paper mills, the textile and slaughterhouse industries, gasworks and industries associated with the metal and finishing trades. Methods of treatment include digestion by biological processes, filtration and settlement methods and various forms of chemical treatment.

Metal-finishing wastes

With wastes from the metal-finishing industries it is usual to adopt chemical processes and settlement to effect complete treatment. An example of this is the neutralisation of acidic or alkaline wastes from pickling or cleaning processes by the addition of a suitable reagent, usually a milk-of-lime slurry, caustic soda or soda ash for the treatment of spent acids or a dilute acid for correction of alkaline wastes. This type of plant is often of simple design and construction, the basic principle being dependent upon whether the liquor is treated by a batch or a continuous flow method. In the former method a vessel or vessels of suitable proportions to retain a predetermined volume of effluent is constructed into which the effluent is discharged and treated on a fill-and-draw principle.

Continuous-flow plants have the advantage of being smaller than the batch type and generally comprise a balancing chamber into which the liquid is discharged continuously and retained for a period of time to even out fluctuation in concentration and flow, followed by passage into a treatment chamber where the reagent is added for correction of *p*H value. A final retention in a settling chamber is normally included to remove solids before discharge of the effluent to the river or drain.

The control of the reagent on the continuous-flow type of plant is frequently carried out automatically by a *p*H control system operating on the electrometric method and consisting of two glass electrodes suspended in the liquor and operating in conjunction with a control system which governs the opening of a valve or control on the reagent storage vessel.

Chromium-plating liquors

The plating industry presents more complex problems of treatment as liquors from this type of process invariably contain chromium, copper and nickel, zinc and often cyanides.

The reduction of chromium can be carried out in several ways dependent mainly upon the total quantities of chromium in the liquor to be treated and the bulk to be handled. The simplest method is by the addition of ferrous sulphate, this being done before neutralisation of an acidic waste as a pretreatment process; neutralisation and settlement then follow as previously described.

The process of neutralisation results in the precipitation of the various metals present in the effluent, including the ferrous salts from the chrome treatment process. In view of the quantities of ferrous sulphate often required for complete treatment the resultant sludge is usually a problem.

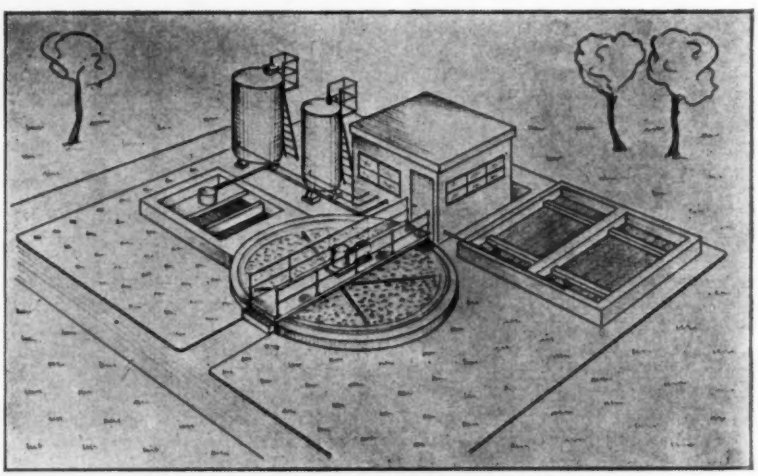
A cleaner and more desirable method of chrome treatment is by the use of sulphur dioxide which may be added to the effluent as a gas and results in a quick, efficient and clean method of treatment. This process is gaining popularity and is almost invariably chosen by the authors' company in designing larger plants.

Cyanide disposal

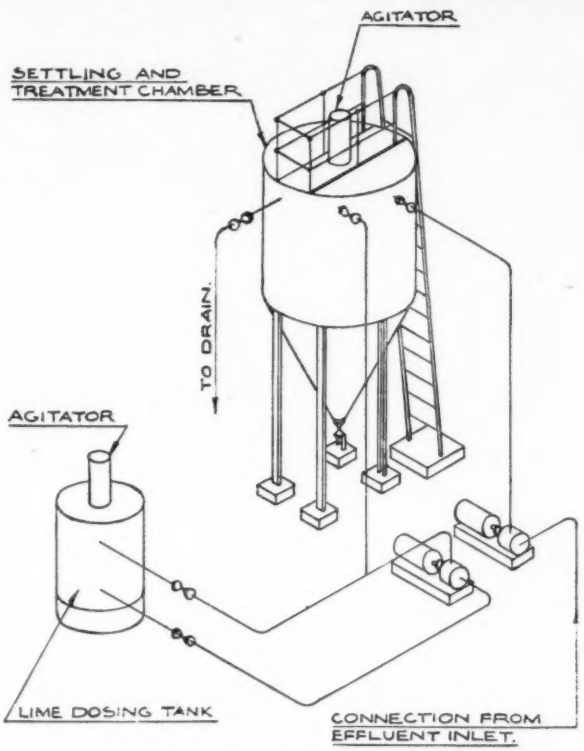
The presence of cyanide in plating-shop effluent demands special care in view of its toxicity. It is capable of giving off hydrocyanic gas in acid conditions and this can be used as a basis for treatment, but the method is seldom adopted in Britain owing to fume disposal problems.

A more usual method of treatment is by the addition of ferrous sulphate or of chlorine as a gas or as a hypochlorite. Ferrous sulphate is generally considered to be unsatisfactory and, although effective on strong solutions of cyanide, seldom gives satisfactory results in more dilute liquors.

Treatment by sodium hypochlorite has been found extremely effective and is often used on small disposal systems where the cyanide solutions



Artist's impression of acid/alkali neutralising plant.



Arrangement of batch-treatment acid neutralising plant.

are dilute and the quantities small. The plant for this type of treatment system is simple, compact and economical under these conditions.

The system found most satisfactory from all points of view, however, is undoubtedly treatment by the addition of chlorine or gas. This method is extremely effective, economical and clean in operation.

Any of the above systems may be operated on the batch or continuous-flow principle and it is often found that a plant comprising a combination of several of the above types is required to effectively deal with an effluent in order to render it acceptable to the local authorities.

Ion-exchange treatment

The treatment of effluents from the metal industries can sometimes be carried out by ion-exchange processes and this is a system that, although relatively new, can be very effective where large quantities of dilute solutions of, for example, chromium-bearing effluent are to be handled. In areas where process water is expensive the ion-exchange principle, which includes the recirculation of water in a closed circuit, can effect considerable savings.

The system operates on established principles comprising the recirculation of the process liquor beds followed by periodic flushing of the beds with acidic and alkaline liquors to effect regeneration. It will be appreciated that, since the regeneration liquors are relatively small in bulk and highly concentrated, the plant for *p*H correction or other treatment may be small and normally of the batch type, giving close and efficient control of the outgoing effluents to drain.

Recovery of waste product

Waste recovery is a subject closely related to the general field of effluent treatment and a recent installation for the recovery of sugar syrups may be taken as an example of what can be done in this direction. In the factory in question it was found that waste liquors from various processes as well as waste after cleaning of vessels contained varying amounts of sugar. The liquors were divided into two categories, the first being the general process waste which involved a liquor of about 60° Brix concentration which had been discoloured, and the second was the wash water which was at about 5 to 10° Brix concentration. The quantities of this ' weak ' liquor were such that the loss of entrained sugar presented a serious problem and this part was therefore tackled first.

Sugar liquors of low concentrations are liable to turn rancid in about 36 hr. so that means of preventing or delaying this had to be found. After considerable investigation this has been accomplished to the extent that the plant can be maintained in service for the whole week with shutdown for cleaning at week-ends only.

The liquor is collected, filtered, treated and pumped to storage and from there it is fed to a distribution system which extends over the whole factory. This system feeds to all points where dry sugar and water are normally required so that, by substituting the ' weak ' liquor for water, a reduction of dry sugar feed can be made in proportion to the strength of the ' weak ' liquor.

Great care is necessary in the design of equipment, pipework, filters, etc., to avoid traps and, where the system is required to ' breathe,' air filtration is necessary. It has been found that the total ' weak ' liquor quantity exceeds the demand, so that plans are now in hand to concentrate the surplus liquor to a more stable level and to decolorise the general process waste mentioned earlier.

Another interesting project in hand is the design of a unit for handling sub-micron steel particles suspended in light oils. Disposal of this material is problematical and, as both oil and particles have a commercial value, recovery is important.

These two very different examples serve to show the wide range of wastes which can be recovered and the economical advantage of installing a suitable recovery system.

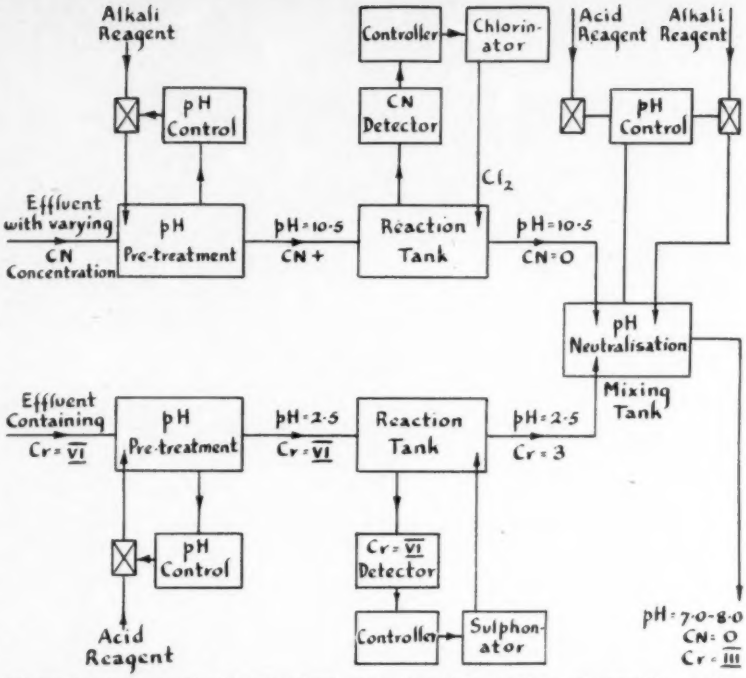
Automatic cyanide and chromate treatment

A new development makes it possible to install complete, automatically-controlled plants for the continuous detoxication and *p*H neutralisation of cyanide and/or chromium-bearing effluents. The effluent passes through a reaction tank which has been specially designed to complete the cyanide or chromate reduction reaction with the appropriate reagent (*e.g.* chlorine

or SO_2) in a very short period of time.

The state of the reaction is continuously monitored by newly-developed electrochemical detector assemblies, which are mounted in the reaction tank; these detectors in conjunction with their electronic amplifiers and controllers regulate the addition of reagent to the continuous flow reaction tank at a rate required to give complete detoxication without over-dosing. Controllers are used to keep the *p*H of the effluent within the required limits (below 2.5 for chromium and above 10.5 for cyanide) for the appropriate treatment, and further *p*H controllers are used for the automatic neutralisation of the effluent before it passes into the drains or rivers.

This equipment, offered by A. M. Lock & Co. Ltd., ensures that continuous treatment plants are of reasonably small dimensions so that, where space is already a problem, this is not unduly aggravated. The instrumentation is available in pre-wired, floor-mounting cubicles ready for immediate installation, the reaction tanks being designed to meet the flow requirements of each particular plant.



Schematic layout of effluent plant, showing detoxication of cyanide and/or reduction of chromates. *p*H pretreatment would be included where necessary.

New Ideas in Effluent Piping

Systems for the conveyance of effluents through pipelines have in the past been added as an afterthought and often little attention has been given to the type of installation likely to prove most efficient and durable. Corrosion has been shrugged off as a necessary evil and frequent repair or replacement accepted as inevitable. This is now more generally recognised as a shortsighted policy, while stricter legislation concerning effluent disposal has also led to better planning and design.

The engineer today has a wide range of materials from which to choose for his effluent piping system and, since effluents vary so widely in character, no general rules can be laid down, the choice depending on the nature of the effluent, the volume to be handled, whether the pipes are to be installed above or below ground, the corrosivity of the environment in which they are placed, etc. Some of the available types of piping and drainage systems are summarised in the following notes.

Spun iron pipes with flexible joints are used for a wide range of trade effluents. In some applications a centrifugally-applied concrete lining may be advocated as a protection for the iron, or in others, synthetic joint rings in place of natural rubber, if deleterious elements are present. The Stanton Ironworks Co. Ltd. report that spun iron pipes and flexible joints are also widely used for ash or coal dust disposal.

Where necessary, pipes with a thickness in excess of normal British Standard are available to allow for the erosive effective of the passing effluent. A more recent trend is to supply flexible joints with special joint rings resistant to temperatures up to 300°F. for use in mains where dry ash or coal dust is to be carried by a stream of compressed air.

Stoneware drainage systems. In industries where corrosive liquids have to be disposed of, underground drainage in pipes of chemical stoneware or glazed earthenware is often favoured. They are available to meet the standards laid down in B.S. 1774, 1143 or 65 and are normally designed for spigot and socket joints. The actual sealing with chemically resistant putties has in the past presented a considerable problem due in the main to lack of adhesion of the materials of construction and to shrinkage on setting. F. Haworth (A.R.C.) Ltd. have developed a composite joint for standard spigot and socket pipes, based on newly-developed sealing compounds. These are claimed to give high chemical resistance and to exhibit remarkable adhesion, even to glazed surfaces, as well as high impact resistance, strength and hardness. There is negligible shrinking on setting and no swelling when in contact with acids.

The compound used for the initial seal is varied to suit chemical conditions; the intermediate flexible lute is of long-fibre impregnated asbestos which fixes the pipes after positioning, allowing for lining up before final sealing. The final seal completely secures the pipe, making it stronger than the pipe itself with positive sealing.

Plastic pipe. Plastics are now becoming increasingly favoured for effluent piping and one notable example is a chemical works in South Wales where a hot and highly corrosive effluent consisting of chlorinated brine at a temperature of 60°C. had to be discharged. Formerly a chlorinated rubber-lined, 6-in. metal pipe, several hundred feet in length, was used, but after barely a year it was so corroded that it had to be scrapped. Continued use of rubber-lined piping would have involved expensive replacement at least once a year. An

alternative material was sought and a 6-in. high-impact rigid *Geon* PVC pipeline was substituted and after three years this showed no signs of corrosion or deterioration.

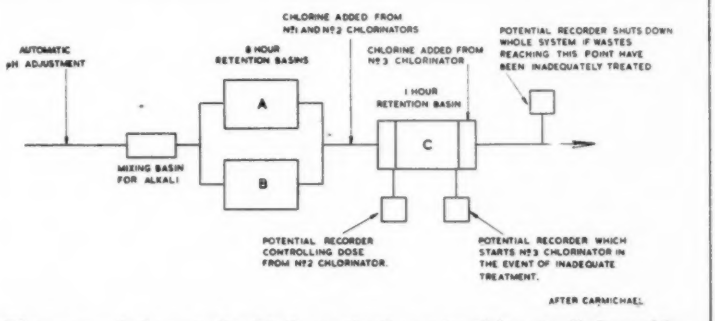
Laboratory wastes and used liquids from other small-scale operations have to be disposed of as well as effluents from full-scale processes. Recent years have seen considerable development of sink traps and waste-line systems in both glass and plastics. Q.V.F. Ltd. have developed systems in borosilicate glass which will stand up to the thermal shock of flushing alternately with boiling liquids and ice-cold water. Glass also has the advantage that the fluid being conveyed is clearly visible, while friction within the smooth glass bore is negligible and no scale forms. Several systems are used to trap effluent from sinks employing either individual glass traps for each sink or traps serving several sinks simultaneously. The waste fluid is then conveyed entirely by glass pipeline from sink to point of drain. One recent installation of this type employed over a mile of glass pipeline.

Drainage systems made from polythene tube and fittings are now available, so that it is possible to have a complete installation in plastics, including moulded sink wastes, drip wastes, deep-seal traps, bends, tees, inspection caps, etc. Monolithic construction of the whole is obtained by welding. The flexibility of polythene enables the system to accommodate itself to most earth settlements without cracking. One company which supplies such installations, A.C. Plastic Industries Ltd., observes that in smaller pipe installations where it is desirable to keep the whole system free from attack, valves moulded or machined in polythene and PVC can be used. A few of the types now available are ' up-and-over ' type wheel valves, non-return valves, ball valves, needle valves, etc. Moulded polythene pipe-clips complete the corrosion-resistant installation.

Handling chemicals in cyanide treatment plants

In the treatment of cyanide wastes by alkaline chlorination and of chrome wastes by sulphur dioxide reduction, close control of chemicals is necessary to avoid discharging an unsatisfactory effluent into a river and to eliminate holdups in plating shops. Chlorinators, reagent feeders and E.C.D. pumps are available for handling a wide variety of solutions, with a high degree of accuracy, the feed rates being controllable over a wide range. The pumps incorporate a system of stroke adjustment which gives linear control from zero to maximum, lending itself admirably to automatic proportioning. Wallace & Tiernan Ltd., who undertake the commissioning of such systems, inform us that for batch treatment of industrial wastes the pumps can be arranged to deliver a predetermined quantity of reagent over a given time interval, and on continuous treatment they can be controlled by the process to give a consistent effluent.

At a motor-car factory where a large variety of plating solutions is used a batch process was adopted, the waste being recirculated through the injector of a chlorinator to ensure intimate and immediate mixing of chlorine, while the *p*H was controlled by suitable acid and alkali dosing pumps. Concentrations of cyanide up to 220 p.p.m. were treated satisfactorily, yielding an effluent at all times completely free from cyanide.



Diagrammatic layout of oxidation reduction potential controlled cyanide waste disposal plant.

British Research on Wastes

Treatment of industrial wastes, including biological processes, comprises an important part of the work being carried out at the Water Research Laboratory (D.S.I.R.) at Stevenage, Herts. Amongst notable problems being dealt with are the treatment of waste waters containing cyanides and the pretreatment of tannery wastes to remove high concentrations of suspended matter, toxic metals and sulphide, while treatment of wastes from distilleries by anaerobic digestion has been successful.

Cyanides

Rinsing waters from processes such as the electroplating of zinc, cadmium, copper and silver, and the case-hardening of steel are likely to contain cyanides, both as the simple sodium cyanide and as complex cyanides of various degrees of stability. They are also present in certain liquors discharged from gasworks and coke ovens. The concentration of cyanide, by treatment with ferrous sulphate and an alkali, may be reduced sufficiently to permit discharge to a sewer. For a higher degree of purification treatment with chlorine and an alkali is very effective. Several plants using this process, which the laboratory has played a part in developing, are at present in use.

In the treatment of water containing simple cyanides and the less stable complex cyanides by passage through a percolating filter or by the activated-sludge process it is possible to build up a biological film which uses the cyanide as a source of carbon. A pilot plant using this process is at present in operation at the laboratory. It is capable of effecting almost complete removal of cyanide from a solution of sodium cyanide equivalent to 90 p.p.m. HCN at a rate of flow of 700 gal./cu.yd./day provided that the temperature of the effluent does not fall below 10°C. The temperature is maintained by enclosing the filter in a light shed and by electrical heating of the incoming liquid. At present a mixture of simple cyanide and the complex cyanides of zinc, copper, and cadmium is being treated, about half the cyanide being added as simple sodium cyanide. This mixture is much less amenable to treatment than the simple cyanide and to remove 95% it is necessary to reduce the concentration to 60 p.p.m. as HCN, to reduce the rate of flow to 150 gal./

cu.yd./day, and to adjust the *p*H to 6.5.

It is thought that under certain conditions such biological processes might provide a satisfactory alternative to chemical treatment.

Tannery wastes

A method of treating chrome tannery waste, possibly cheaper than settlement followed by chlorination, might be to neutralise the settled wastes with carbon dioxide in the form of flue gas which could be bubbled through the wastes. Lime would be precipitated as calcium carbonate and, if the process were continued, sulphide would be stripped out.

To overcome the nuisance of hydrogen in the atmosphere, a method successfully used in the laboratory is to pass the waste gases containing hydrogen sulphide into a coke-packed filter, irrigated with a mixture of the less polluting tannery wastes. Hydrogen sulphide is absorbed and oxidised by bacteria to sulphuric acid. A possible difficulty, however, is that the efficiency of the process falls off appreciably at low temperatures.

Experiments are also being made on treatment of a mixture of settled tannery wastes on a percolating filter, using a high rate of recirculation of effluent in order to reduce the alkalinity of the waste water applied. This would be an effective and convenient form of pretreatment but for the fact that chalk is deposited in the filter and might, in time, cause blockage. At a loading of 0.29 lb. B.O.D./cu.yd./day, 95% of the sulphide, 80% of the five-day B.O.D. and 60% of the 4-hr. permanganate value is removed.

Anaerobic digestion

The purification of industrial wastes containing relatively high concentrations of organic matter by the process of anaerobic digestion has been successfully carried out and, though long used for reducing organic matter in sewage, has not so far been widely applied in industry.

A 500-gal. digester, based on small-scale experiments, for slaughterhouse waste has been operating for over a year. With a waste of average B.O.D. 2,000 p.p.m. and a digestion temperature of 33°C., an average of 0.11 lb. B.O.D./cu.ft./day digester space could be destroyed. Production of methane gas or carbon dioxide was not sufficient to make the process self-supporting.

Even better digestion has been achieved, in small-scale digesters, of whisky distillery wastes of B.O.D. 25,000 p.p.m., with average daily loadings of 0.25 lb. B.O.D./cu.ft. digester space, and gas production in this case was such that surplus energy should be available.

Two important factors in maintaining a high rate of digestion of both wastes were the degree of agitation of the digester contents and the return to the digester, without delay, of sludge settled from the digester effluent. Gas entrained in sludge particles, which hinders settlement, is released by first passing the effluent through a small, gently stirred vessel and then through a shallow sedimentation tank with a spiral baffle.

Coke-oven effluents

Staff from the National Coal Board are studying the microbiology of the treatment of coke-oven effluents, and work is also being carried out in connection with the use of synthetic products in the coalescence of colloidal or very fine particles.

Impervious Graphite

To the Editor

DEAR SIR,

I was very interested in the ' Guide to Materials of Construction ' which was inserted between pages 134 and 135 of your April 1959 issue. My particular interest was in the part dealing with impervious graphite, as this appears to illustrate some of the points which I was trying to drive home in my article, ' Graphite as a Material of Construction for Heat Exchangers,' on pages 127-129 of that same issue.

It seems to illustrate that graphite (and other ' new ' materials) cannot easily be classified under the same headings of properties as are applied to conventional constructional metals. Whereas the tensile strength of the latter is a highly pertinent and important design property, the opposite is the case with graphite. The low tensile strength of 2,500 p.s.i. which is quoted in the table shows that graphite should be used in a form which avoids tensile stresses and which takes advantage of the good compressive strength of the material (approximately 15,000 p.s.i.).

The thermal conductivity figure of 85 (B.Th.U.) (hr.) (sq.ft.) (°F./ft.) seems to apply usually to a particular form of polycrystalline graphite in one (preferred) direction only. Because of the highly anisotropic nature of graphite, the thermal conductivity may vary considerably if measured at right-angles to the direction for which the value of 85 was cited.

Brown *et al.*[1] found that a certain form of carbon can have a thermal conductivity as much as 40% greater than that of copper. Krishnan and Ganguli[2] established that the electrical conductivity of graphite crystals is at least 10,000 times greater in the direction of the long axis than in the direction of the short axis. Other information bearing on this subject was published by Dutta,[3] Tyler and Wilson[4] and Goetz and Holser.[5] They were also discussed in one of my earlier papers, read before the Carbon and Graphite Conference in 1957.[6]

The thermal conductivity figure of 85, mentioned in the table, applies usually to extruded graphite tubes, parallel with the bore. However, the conductivity across the walls of such tubes, namely the direction in which heat transfer is normally required, is usually smaller. Similar considerations seem to apply also to some of the other figures cited for graphite in the table, and they relate to a considerable extent to the fact that, unlike most constructional metals, graphite is highly anisotropic.

This appears to confirm the message which I tried to convey in my article, namely that design considerations established for certain groups of materials are not necessarily applicable to new materials of different properties. Likewise, the tabulation of pertinent properties of ' new ' materials may not always be practicable under similar headings, as applicable to the former.

Commending the above to your kind attention, I am,

Yours very truly,

A. HILLIARD,
Technical Adviser,
Société Le Carbone-Lorraine

REFERENCES

[1] A. R. G. Brown, W. Watt, R. W. Powell and R. P. Tye, *Brit. J. Appl. Phys.*, 1956, **7.**

[2] K. S. Krishnan and N. Ganguli, *Nature* (Lond.), 1939, **144,** 667.

[3] A. K. Dutta, *Phys. Rev.*, 1953, **90,** 197.

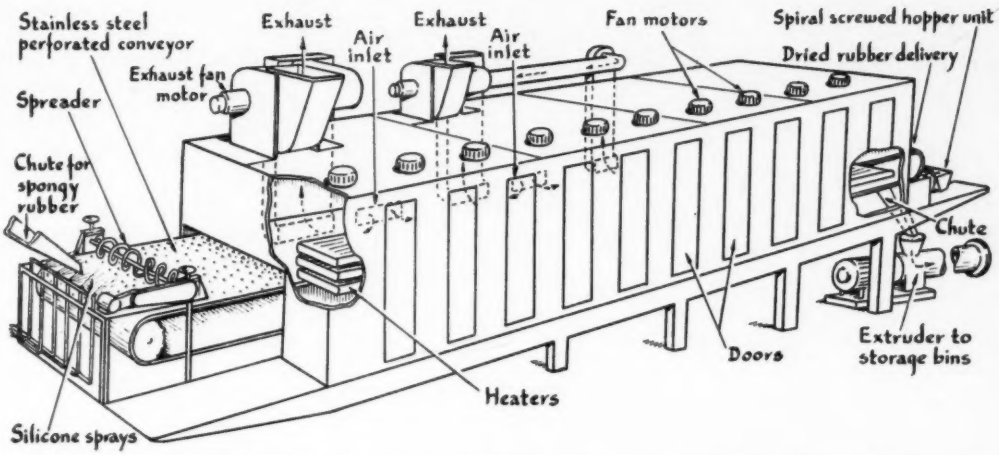
[4] W. W. Tyler and A. C. Wilson, *Ibid.*, **89.**

[5] A. Goetz and A. Holser, *Trans. electrochem. Soc.*, 1942, **82,** 391.

[6] A. Hilliard, ' Some Recent Developments in Graphite Heat Exchangers and Similar Equipment,' Carbon and Graphite Conference, Society of Chemical Industry, London, Sept. 1957.

As was stated on the chart, physical properties given were for Karbate *impervious graphite. It was also pointed out that the chart was only a general guide to materials.*—EDITOR.

Conveyor Driers Solve Problems at French Butyl Rubber Plant



Our artist's impression of one of the driers at the Le Havre butyl rubber plant, seen from the feed end. The helical spreader seen on the left has a left-hand turn at one end and a right-hand turn at the other, *i.e.* with a change in the middle so that the material is spread out from the centre. The exhaust ducts, as shown by the broken outline, are led down the far side of the machine to openings in the side between the top and bottom slats of the conveyor.

Inclined drying tunnels keep the production line 'on the level' at Europe's only butyl rubber plant at Le Havre, France. These unusual driers, supplied by a British firm, are described below.

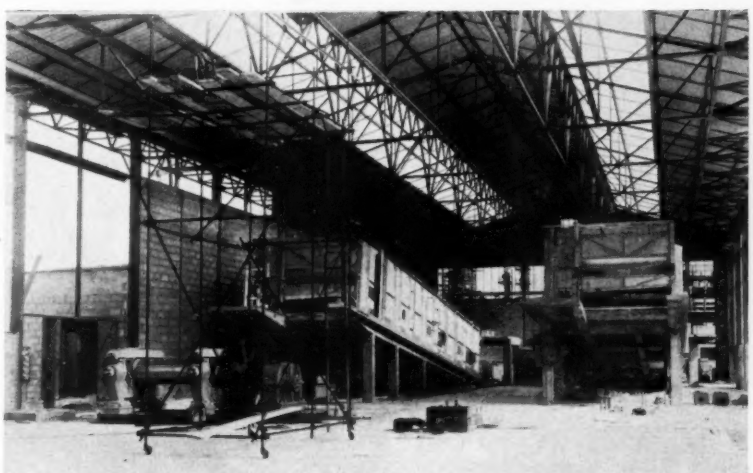
IN the production of butyl synthetic rubber by the Société du Caoutchouc Butyl, alongside their new petrochemical plant at Port Jerome, near Le Havre, France, two big conveyor driers have an important part to play in aiming at the plant's planned production capacity of 20,000 tons p.a. Each of the two machines is 50 ft. long and has a designed output of 3,450 lb./hr. of dry product (from 50% moisture content down to 0.5%). In the design of this installation, the problems that had to be overcome included the following:

● **How to keep the production line on one level.** This was answered by mounting the two driers on reinforced-concrete ramps inclined at 7° from the factory floor so that the dried rubber could drop into storage bins at ground level. This also meant that machinery for subsequent stages of the process could be installed under the delivery end of the conveyor, and the expense and trouble of digging a pit below ground level was avoided.

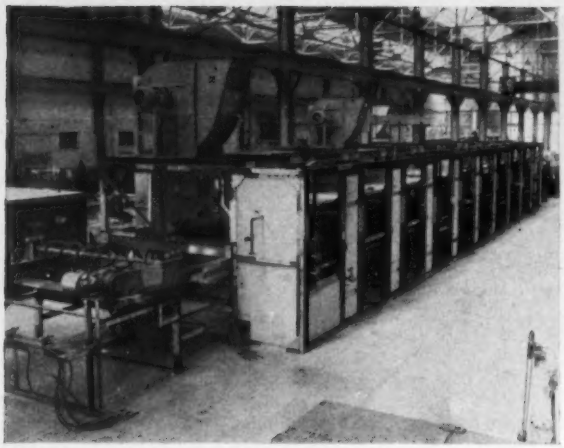
● **Overcoming the tendency of the product to stick to the stainless-steel conveyor slats.** This was solved by introducing silicone fluid sprays at a point immediately preceding the product feed. The conveyor slats are sprayed on both sides.

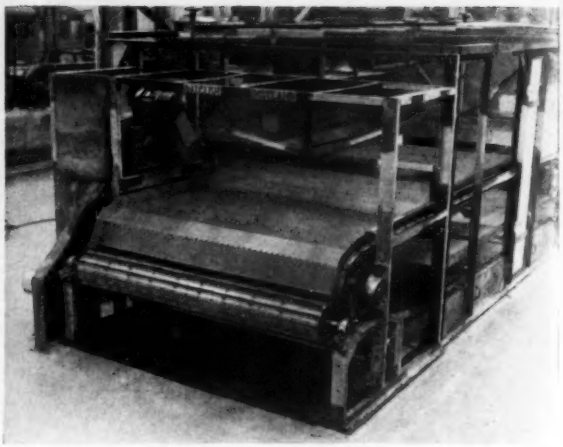
● **Dealing with corrosive fumes** given off by the product in the drying process. This called for a specially designed drying chamber and a lining of asbestos-type insulating panels had to be mounted inside the steel framework of the drying tunnel.

● **Fire hazard** had also to be taken into account, and the drying chamber was equipped with an automatic sprinkler system designed to operate whenever the temperature inside the drier exceeds the safety level.



The two conveyor driers as they appeared during construction work at Port Jerome.





Two photographs taken while the conveyor driers were under erection in Scotland. *Left:* **From the feed end, with access doors closed. Exhaust fans, steam heaters, panelling, ramshorn spreader, silicone spray heads and piping can also be seen.** *Right:* **Delivery end, showing perforated stainless-steel conveyor, main drive and doffing roll.**

The drying process

The rubber, in the form of spongy agglomerate particles ranging in size from $\frac{1}{8}$ to $\frac{1}{2}$ in., reaches the feed end of the drier in a comparatively narrow stream. It is spread evenly across the full width of the conveyor band by a revolving scroll arrangement having right and left helices. The speed and height of this scroll may be varied during operation.

The conveyor carries the particles through four separate temperature-controlled compartments. Three fans are installed in each of the first two chambers and two fans in each of the remaining two.

The drying air is drawn through gilled tube steam-heaters, directed by the fans into the bed of synthetic rubber particles, through perforations in the conveyor, and recirculated through the heaters. Moisture-laden air in controlled amounts is drawn off by an exhaust system at three points along the length of the drier.

Conveyor

The conveyor is the standard 8-in. pitch Proctor-Dalglish design, having steel links and pins with hardened rollers and bushes. The stainless-steel slats, hinged to each other, are suitably reinforced by members running the full width of the conveyor. The piano-type hinges used are not subject to wear since all the driving load is carried by steel chain links.

The specially elongated perforations in the slats allow a full flow of air. They also prevent all but the finest of the particles from falling through.

A continuous intermeshing wall runs vertically along the full length of the conveyor, deep side guards having been mounted at either end of the conveyor slats. There is no leakage of drying air because the outside faces of these side guards are themselves shielded by the fixed side guards. This arrangement also prevents contamination of the chain parts by product fines carried in the air stream. The driving chain is automatically lubricated.

Other features of driers

At the delivery end of the conveyor a doffer roll removes the product which falls into a trough equipped with a left- and right-hand pitched ribbon scroll. This scroll draws the dried synthetic rubber to the centre. The product falls through a discharge hole to the storage bin at ground level.

In driers of this type, freedom of access is important. Twenty full-length doors, 10 on each side of the drying chamber, are provided on each of the two machines. Between the two runs of the conveyor a smooth sub-floor is mounted. This may easily be swept clear of fines that may drop through the conveyor perforations.

International effort

The drying machines were manufactured by John Dalglish & Sons Ltd., Glasgow, and are similar to those built by their American associates, Proctor & Schwartz, Inc., for the Standard Oil Co.'s installations at Baton Rouge, Louisiana.

The Le Havre drying installation is noteworthy not only for its technical features but also for the degree of international co-operation it involved. Standard Oil's research company, 'Erco,' were consultants; the firm of C. F. Braun, California, were responsible for design with Compagnia Tecnica Industrie Petroli of Rome as design sub-contractors. Dalglish staff co-operated with C.T.I.P.'s offices in Paris and Rome.

Esso Petroleum Co. Ltd., London, made the commercial arrangements for 'Socabu' and Esso France. The work involved visits of Proctor & Schwartz personnel to Baton Rouge and New Jersey, U.S.A., and of Dalglish staff to New Jersey, London and Paris.

British Standard

Low-density Polythene Sheet

The latest addition to the series for polythene (B.S. 3012: 1958, 3s.) specifies the composition, chemical properties and dimensional tolerances of low-density polythene sheet with a maximum nominal thickness of 0.020 in. The sheet is primarily for use in conjunction with low-density polythene tube and rod (B.S. 1973, 2919, respectively).

The publication deals with black and natural colour sheet suitable for general purposes, including those of the chemical and food industry; and with pink and brown coloured sheet for use as external surgical splints. (Pink and brown are specified by reference to the British Standards for building and decorative paints.)

The standard concludes with a set of marking requirements, with a note on B.S.I.'s 'kite-marking' scheme, and an appendix deals with the method of measuring the thickness of the sheet.

FRACTIONAL DISTILLATION

By H. H. M. Jones, B.Sc., A.M.I.Chem.E.

PART 2 — *Miscellaneous approaches to distillation calculations; rectification; new aids to laboratory studies; comparisons of various contacting devices; sampling and control techniques; some specific separating problems; economic aspects of fractionation; etc.*

Mathematical design of columns

THE mathematical basis of fractionation is reviewed and expounded by several workers. Boutaud[74] restates the principles of calculation of fractionation and Mestres[75] makes a mathematical and physical comparison between the principles of the equivalent theoretical plate due to Fenske,[76] McCabe and Thiele[77] and that due to Jaulmes[78] which applies to the distillation of a solution containing a solute of varying volatility. The equivalence of the theories is established and confirmed by a consideration of the aqueous solutions of organic acids, alcoholic solutions of esters and the ethanol/water system. The divergences observed in practice do not then arise from deviations between the principles of the methods. Mole[79] presents a unified theory for ideal separation processing capable of application to all steady states stagewise countercurrent processes, including fractionation, liquid/liquid extraction, etc., and a general equation is derived. A rigorous graphical method for the resolution of multi-component fractionation is due to Hengstebeck and Schubert.[80] The method minimises the tedious tray-to-tray calculation and avoids matching to locate the feed tray. Simple equations are also presented for approximating the splits of components other than the keys. Again, Hengstebeck[81] suggests reducing multi-component mixtures to binaries of the effective key component to determine tray and reflux requirements. The method is claimed to be suitable for single or dual-feed towers and with sidestreams.

Another approach to direct calculation of the number of theoretical plates required in a column is due to Thun,[82] who treats the problem of separation at a finite reflux ratio of the distillation of binary mixtures having unequal latent heats of vaporisation. This solution requires the use of three computable parameters; the method is the equivalent of the use of enthalpy diagrams with straight but non-parallel enthalpy curves. For the special case of calculation of plates where the amount of one component is small, Szapiro[83] proposes an analytical method for the separation of a binary system at any pressure. Two equations are given, the first for use when the fraction of one component is small and the second where both components approach the azeotropic composition. The variables in the

A CPE Chemical Engineering Review

equation are the directional coefficients of the tangent line to the McCabe Thiele curve, the coefficient of the operating line in the McCabe Thiele curve ($y = ax + b$) and the azeotropic composition. For the next special case of the calculation of the number of plates for the separation of an ideal binary with small separation factors and finite reflux, Junge[84] considers the method of Matz[85] to be very tedious under these conditions and his method is based on the use as the equilibrium curve not of the separation factor curve itself but of a curve of the, say, fifth to tenth power of the separation factor. Another special problem is the rectification of partially miscible binaries and this is treated by Gel'perin and Gidroliz.[86] Equations for the material balance in the rectification of such mixtures as water/butyl alcohol and water/furfural are developed.

Graphical methods for binary separations

In the field of a graphical solution to the problem of the separation of binary mixtures by fractionation, there have been several contributions. Tsygankov[87] considers a simple fractionating column operating with open steam and equipped with a side stripper, and adopts the Sorel approach in developing a graphical method. Billet[88] also considers the enthalpy of the system and takes into account differing molal latent heats of the two components in his semi-graphical procedure for determining the operating lines in both sections of the column. The McCabe Thiele method serves as the starting point for Horvath and Schubert[89] in their graphical method based on log co-ordinates for separations involving very high or very low concentrations. The same McCabe Thiele diagram is the basis of a discussion of the mathematical principles of rectification of ideal binary mixtures by Junge[90] in association with Raoult's law. On the contrary, Cardona[91] bases his nomogram of a number of plates in a fractionating column at infinite reflux on Fenske's equation, and rules are given to permit its use for partial and total condensers. The simplification of the graphical calculation of fractionating columns is considered by Piazza[92] to be furthered by the application of the theorem of Ceva[93] which was used to determine geometrically the relative volatility in a binary mixture.

Calculation by computer

Two examples of the use of a computer to simplify the calculation of the separation of a multi-component mixture are noted. Firstly, Amundson and Pontinen[94] used a *Univac* model 1103 to resolve the separation of a five-component light hydrocarbon mixture, and Edmister[95] who developed new absorption and stripping factor functions in computing the separation of a multi-component mixture in a fractionator and columns with sidestream strippers. Charts of fractions not absorbed *v.* absorption factor and fraction not stripped *v.* stripping factor, are included with the equation for these operations. These equations are of particular advantage in computing complex columns, *i.e.* two or more feeds, three or more products, where the proposed absorption and stripping factor equations provide a method for converging on a solution and which are particularly adapted to computer resolution.

Reflux and thermodynamic efficiency

Distillation at minimum variable reflux is the subject of two papers by van Wijk and Bruijn.[96, 97] They

calculate the minimum reflux by Underwood's method[98] for the situation in which the reflux ratio varies throughout the column. The theoretical basis is established and generalised equations presented which are dependent on the molal latent heats of the liquid. The method is then applied to a six-component system consisting of methane and its higher homologues.

Fractionation was examined from a thermodynamic standpoint by Trevissoi[99] who applied the principles of thermodynamics of irreversible processes to evaluate analytically the minimum work of separation and the thermodynamic efficiency of continuous fractionation processes for ideal binary systems. A somewhat similar approach is that of Kuhn *et al.*[100] who defines the thermodynamic efficiency of fractionation as the quotient of the energy necessary to separate the components isothermally and reversibly compared with that actually used. This efficiency will be small and it is suggested that a heat pump should be used to recycle the heat of condensation during refluxing. The smaller is the difference in boiling points between the components, then the smaller is the efficiency. When a heat pump is used the efficiency depends only on the initial and final concentrations of the volatile component and is independent of pressure, temperature and boiling point difference.

Heat transfer *v.* mass transfer rate functions

A new approach to the analysis of fractional distillation is that of Stern *et al.*[101] They make a calculation based on a heat-transfer rate function rather than a mass-transfer rate, as represented by the usual Murphree efficiency. Data on five systems show that this heat-transfer rate function may correlate better than the Murphree factor with vapour velocity and the physical properties. It is further suggested that the ratio of physical properties of the components may be more significant than the physical properties of the mixture. On the other hand, Rosen[102] has developed the concept of mass transfer in a fractionating column to assist in the understanding of unsteady-state rectification. He was of the opinion that an understanding of this process was hindered by the mathematical difficulties connected with the concept of the theoretical plate. From the usual equations of mass transfer modified by factors peculiar to holdup on a fractionating plate and from a material balance, a second order differential equation was derived. The latter could be simplified to the first order when the column capacity was small compared with that of the still. Again, by the use of the similarity principle, the number of transfer units was determined by measuring the concentration distribution up the column for the unsteady process. The related problem of the rate of approach to a steady state in a fractionating was facilitated for Jackson and Pigford[103] by the use of a large-scale digital computer to assist in the numerical solution of simultaneous ordinary differential equations leading to an approximate method of solution. A computer was also resorted to by Rosenbrock[104] as the most promising method of calculation for the transient behaviour of distilling columns. The kinetics of rectification of binary mixtures with relative volatility approaching 1 is analysed mathematically and graphically by Fraiman[105] in the period between the start of distillation and the attainment of a steady state. It is shown that the assumption of Huffman and Urey[106] and Brodskii *et al.*[107] and supported by Coulson,[108] namely, that equilibrium in the column is reached when there is still a difference in the concentration between rising vapour and reflux downflow, cannot be correct.

Finally, there is an approximate method by Wilkinson and Armstrong[109] for predicting composition response of a fractionating column to changes in feed composition, and the investigation into the effectiveness of a plate in the processing of the rectification of binary systems by Ruckenstein,[110] which is a theoretical exposition of the overall effectiveness of a plate allowing for local differences of agitation by the rising vapour. A full analysis is made and equations are derived. In the special sphere of ternary mixture separation, Osburn[111–113] reviews methods of handling such mixtures and presents equilibrium data for vapour/liquid and liquid/liquid systems.

Rectification reviews

A significant gap in the literature on rectification available in English is filled by Aerov and Maliusov,[114] who give a comprehensive review of Russian work in this field in the last ten years and include 104 references. Other reviews covering a more limited time period are due to Colbourn and Gerster[115] and to Kirschbaum,[116] the latter also covering rectification under reduced pressure. Grassmann[117] makes a comprehensive survey of the factors which influence enrichment on a rectification plate and gives an analysis of the present methods available for their prediction.

Laboratory apparatus

In the field of strictly laboratory high-efficiency fractionation columns there have been several reports. Ray[118] describes a low-holdup column with indentations in the wall of the tube. It is important that these should be precisely formed and a jig is described for this purpose. Kawis[119, 120] describes a 20-plate column of copper for the laboratory investigation of the continuous rectification of ethanol/water mixtures. The performance of the laboratory bubble-cap column developed by Bruun[121] and by Oldershaw[122] for perforated plate glass columns are compared by Ellis and Bahari.[123] They use various binary mixtures for this purpose. The importance of reproducing on a laboratory scale continuous fractionation techniques is emphasised by Biribauer *et al.*[124] who describe a bench-scale continuous apparatus with a nominal throughput of up to 5 litres/hr. which was operated to collect pilot-plant data. Great efforts were made to reproduce all industrial factors and the apparatus was capable of operation over long periods without supervision. It was used for the fractionation of benzene from a refinery stream after hydroforming using phenol as an extractant.

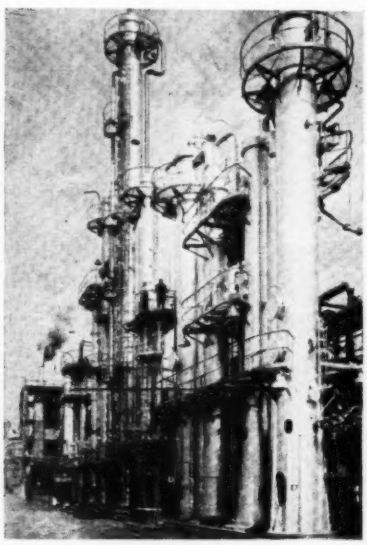
Contacting devices

There were several reports of the application of unconventional methods of fractionation and of the introduction of novel apparatus. The *Turbogrid* tray has been known and applied for several years and it is compared with the bubble-cap tray by Majewski[125] to the disadvantage of the latter. Under similar conditions the *Turbogrid* has a capacity 60% greater. It also has a low pressure drop which was calculated by the method of Dil'man *et al.*[126]

Kent and Pigford[127] stress the advantages of fractionation during the condensation of vapour mixtures and claim that a dephlegmator was capable of a great fractionating effect. Experimental studies of the ethylene dichloride/toluene mixture show mass transfer effects as predicted by the Colbourn and Drew film theory.[128] A new equation was developed for the number of transfer units related to the liquid and gas phase resistances, the surface area and the amount condensed.

A new method of dispersing the

liquid phase by an application of the high velocity of the vapour phase was described by Berry,[129] who presented preliminary theoretical experimental pilot studies of an 'impact-spray' fractionating column. The device depends on the dispersion of the liquid phase and its removal from the vapour phase by impact against the column wall. Claims are made for a very low pressure drop for this type of apparatus. A cheap vapour/liquid contacting device is the ripple tray described by Hutchinson and Baddour;[130] this tray is made from sheet metal perforated in the flat and then bent into sinusoidal waves. The construction, operating variables and pressure drop are discussed and some comparative data include the treatment of crude petroleum fractions. The *Kaskade* column has already a wide application and overall and liquid film efficiencies in such a contacting device are investigated by Garner *et al.*[131] They find that at infinite reflux ratio the gas film resistance decreases with increasing vapour velocity, whereas the liquid film resistance remains relatively constant. Figures are given to show the variation in overall and liquid film efficiencies with increasing vapour velocities for methyl cyclohexane/toluene and methanol/water. At infinite reflux ratio the gas film is more controlling than is the liquid film at low vapour velocities, but progressively less controlling with increasing vapour velocity, whereas the liquid film efficiency remains relatively constant.



Series of fractionating towers of an isopropanol synthesis installation in Germany, to the process design of Petrocarbon Developments Ltd.

Control techniques

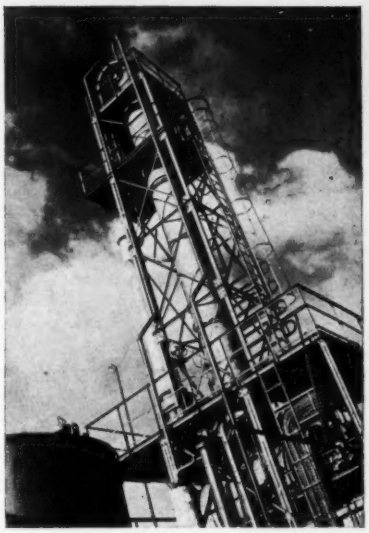
On an industrial scale the method of controlling continuous fractionation columns is of considerable importance and Williams and Harnett[132] describe sampling and control techniques which are necessary using such instruments as a mass spectrometer and ultra-violet and infra-red spectrometers. These are evaluated from the control dynamics aspect. In another paper, Williams *et al.*[133] show that the problem of varying feed rates can be handled in the same way as that of varying feed compositions by adding a separate controller to the system to maintain boil-up rate as a definite multiple of the feed rate. This they arrived at by the use of computer calculations. Williams again[134] presents information of a more practical than theoretical nature and forming the basis of a workable arrangement for controlling fractionating columns. Each problem can be resolved into three parts, determining which two of four possible internal independent variables should apply, and which method is most direct for sensing variation in these independent variables specified as constant, and how the displaced variable can be restored to its chosen operating value through adjustment of the control system.

Some specific separating problems

In the sphere of low-temperature air separation plant, safe design and operation is discussed by Kerry,[135] while Budnevick and Kondryakov[136] present methods for adjusting thermodynamic data used in low-temperature work from different sources to a common enthalpy datum. Calculations are then roughly outlined for determining composition and heat balances in a relatively complex multi-pressure triple-column system for air fractionation.

The classical fractionation problem of the separation of ethanol and water is discussed by various workers. Tsygankov and Stabnikov[137] describe a column and specify the number of plates for the resolution of this problem starting with various mixtures of various concentrations.

Gryaznov *et al.*[138] write of the 'intensification' of the boiling region of the fractionating column in the rectification apparatus for the separation of alcohol and water. They describe the improvement in fractionation by moving up the position of the feed inlet after analysis of the product from plates 15, 30 and 45 of the column. When methanol is added



Vacuum distillation plant for the removal of inhibitor from styrene monomer at a polystyrene plant in France.

to make a ternary mixture of the ethanol/water binary, separation is complicated by the fact that ethanol is less volatile below the feed and more volatile above it. Aerov *et al.*[139] describe two experiments which yield a plate efficiency of 60% and 82% for this separation. It is shown that experimental compositions on the various plates agreed with those previously calculated.

Economics studies

The question of steam economy in the production of absolute alcohol is discussed by Venkiteswaran[140] who claims a new system and predicts a 30% saving in steam where the heat content of the vapours from the head of the rectifier are used in the dehydrating column. The bottom of the boiling column is at a pressure of about 14 p.s.i.g., corresponding to 8 to 9 p.s.i.g. at the top of the rectifier. Vapour recompression and the use of columns in double-effect are discussed.

The economic aspects of the sizing of fractionating columns are stressed by Pastonesi and Avanzi[141] who present a method for determining the minimum cost of a bubble-cap column for a specified separation and feed rate once the number of plates and the plate spacing have been determined. Such factors as plates, fittings and shell insulation, etc., are considered and an expression is obtained with a single variable of the superficial vapour velocity. The derivation is arrived at in three stages: in the first the overall efficiency for zero

entrainment is obtained according to O'Connell's correlation,[142] then the entrainment is predicted according to the method of Simkin *et al.*[143] and, finally, the overall plate efficiency with entrainment is calculated from the Colbourn correlation.[144] An example of the separation of toluene from benzene is worked to show the application of the method.

A suggested improvement in the thermal efficiency of a fractionating column is suggested by Tariel[145] who analyses carefully the use of two columns in double-effect for the production of a pure compound by fractionation. Whilst the added complication of a chemical reaction taking place during fractionation is the subject of papers by Marek.[146, 147] He visualises a column in which the reaction between acetic anhydride and water takes place from which excess water is removed as a fractionated head product. Experimental work follows and the composition of the liquid on various plates is determined and the values compared with those calculated by a computer method and from physical chemical data previously given.[148, 149, 150] The differences between the calculated and experimental values do not exceed $\pm 4\%$.

REFERENCES

(*References* 1 *to* 73 *appeared with Part* 1 *of the article*)

[74]P. Boutaud de la Combe, *Rev. int. franc. pétrole et Ann. combustibles liquides*, 1956, **11,** 913.
[75]R. Mestres, *J. Chim. Phys.*, 1958, **55,** 370.
[76]M. R. Fenske, *Ind. Eng. Chem.*, 1932, **24,** 482.
[77]W. L. McCabe and M. Thiele, *Ibid.*, 1925, **17,** 605.
[78]P. Jaulmes, *Chim. Anal.*, 1953, **35,** 82.
[79]P. D. A. Mole, *Chem. Eng. Sci.*, 1958, **8,** 236.
[80]R. J. Hengstebeck and D. W. Schubert, *Chem. Eng. Prog.*, 1957, **53,** 243.
[81]R. J. Hengstebeck, *Petrol. Engr.*, 1957, **29** (12), C6.
[82]O. Thun, *Chem. Ing. Tech.*, 1957, **29,** 675.
[83]S. Szapiro, *Przemysl. Chem.*, 1956, **35,** 106.
[84]C. Junge, *Chem. Tech.* (Berlin), 1956, **8,** 642.
[85]W. Matz, *Angew. Chemie.*, 1947, **B19,** 131.
[86]N. I. Gel'perin and E. N. Gidroliz, *Lesokhim. Prom.*, 1957, **10** (4), 3.
[87]P. S. Tsygankov, *Trudy Tekhnol Inst. Pischevoi Prom. im A. I. Mikoyani*, 1955, **15,** 224.
[88]R. Billet, *Chem. Ing. Tech.*, 1958, **30,** 513.
[89]P. J. Horvath and R. F. Schubert, *Chem. Eng.*, 1958, **65** (3), 129.
[90]C. Junge, *Chem. Tech.* (Berlin), 1956, **8,** 579.
[91]S. Cardona, *Rev. Soc. quim Mexica*, 1958, **1,** 120.
[92]J. Piazza, *Rev. fac. ing. quim.*, 1955, **24** (38), 89.
[93]F. Schlömilch, *Mathematik*, 1880, **1,** 240.
[94]N. R. Amundson and A. J. Pontinen, *Ind. Eng. Chem.*, 1958, **50,** 730.
[95]W. C. Edmister, *A.I.Ch.E.J.*, 1957, **3,** 165.
[96]W. R. van Wijk and P. J. Bruijn, *Chem. Eng. Sci.*, 1956, **6,** 79.
[97]*Idem, Ibid.*, 1958, **8,** 225.
[98]A. J. V. Underwood, *Chem. Eng. Prog.*, 1948, **44,** 603.
[99]C. Trevissoi, *Ann. Chim.* (Rome), 1957, **47,** 530.
[100]W. Kuhn, A. Norten and E. Peterli, *Helv. Chim. Acta*, 1957, **40,** 1066.
[101]H. Stern, P. G. Deshparde and S. A. Murdock, *Trans. Indian. Inst. Chem. Engrs.*, 1958, **8,** 6.
[102]A. M. Rosen, *Dokaldy Akad Nauk S.S.S.R.*, 1956, **107,** 295.
[103]R. F. Jackson and R. L. Pigford, *Ind. Eng. Chem.*, 1956, **48,** 1020.
[104]H. H. Rosenbrock, *Brit. Chem. Eng.*, 1958, **3,** 364, 432, 491.
[105]R. S. Fraiman, *Zhur. Priklad. Khim.*, 1957, **30** (12), 1763.
[106]J. R. Huffman and H. C. Urey, *Ind. Eng. Chem.*, 1937, **29,** 531.
[107]A. I. Brodskii and O. K. Skarne, *Acta Physiochim. U.R.S.S.*, 1939, **10,** 729.
[108]E. A. Coulson, *J. Soc. Chem. Ind.*, 1945, **64,** 101.
[109]W. L. Wilkinson and W. D. Armstrong, *Chem. Eng. Sci.*, 1957, **7,** 1.
[110]E. Ruckenstein, *Zhur. Priklad. Khim.*, 1957, **30,** 1012.
[111]J. O. Osburn, *Chem. Eng.*, 1957, **64** (3), 278.
[112]*Idem, Ibid.*, 1957, **64** (4), 284.
[113]*Idem, Ibid.*, 1957, **64** (5), 276.
[114]M. E. Aerov and V. A. Maliusov, *Brit. Chem. Eng.*, 1958, **3,** 486.
[115]A. P. Colbourn and J. A. Gerster, ' Proc. 4th World Petrol. Congr.,' Sect. III, p. 71. Rome, 1955.
[116]E. Kirschbaum, *Chem. Ing. Tech.*, 1957, **29,** 159.
[117]P. Grassmann, *Ibid.*, 497.
[118]J. D. Ray, *Rev. Sci. Instr.*, 1957, **28,** 200.
[119]M. Kawis, *Magyar Kémikusok Napja*, 1954, **9,** 246.
[120]*Idem, Hung. Tech. Abs.*, 1955, **7** (2), 5.
[121]J. H. Bruun and W. B. M. Falconer, *Ind. Eng. Chem.* (Anal. Edn.), 1937, **9,** 192.
[122]C. F. Oldershaw, *Ibid.*, 1941, **13,** 265.
[123]S. R. M. Ellis and E. P. Bahari, *Birm. Univ. Chem. Engr.*, 1956, **8,** 7.
[124]F. A. Biribauer, H. T. Oakley, C. E. Porter, J. H. Staib and J. Stewart, *Ind. Eng. Chem.*, 1957, **49,** 1673.
[125]J. Majewski, *Przemysl. Chem.*, 1958, 37, 144.
[126]V. V. Dil'man, E. P. Darovskikh, M. E. Aerov and C. S. Aksel'rod, *Khim. Prom.*, 1956, 156.
[127]E. R. Kent and R. L. Pigford, *A.I.Ch.E.J.*, 1956, **2,** 363.
[128]A. P. Colbourn and T. B. Drew, *Trans. Inst. Am. Chem. Engrs.*, 1937, **33,** 197.
[129]J. L. Berry, *Génie Chim.*, 1958, **79,** 129.
[130]M. H. Hutchinson and R. F. Baddour, *Chem. Eng. Prog.*, 1956, **52,** 503.
[131]F. H. Garner, S. R. M. Ellis and E. S. Luxon, *J. Inst. Petrol.*, 1957, **43,** 86.
[132]T. J. Williams and R. T. Harnett, *Chem. Eng. Prog.*, 1957, **53,** 220.
[133]T. J. Williams, R. T. Harnett and A. Rose, *Ind. Eng. Chem.*, 1956, **48,** 1008.
[134]T. J. Williams, *Ibid.*, 1958, **50,** 1214.
[135]F. G. Kerry, *Chem. Eng. Prog.*, 1956, **52,** 441.
[136]S. S. Budnevick and I. K. Kondryakov, *Trudy Leningrad Technol. Inst. Kholodil Prom.*, 1956, **11,** 16.
[137]P. S. Tsygankov and V. N. Stabnikov, *Ibid.*, **16,** 121.
[138]V. P. Gryaznov, K. A. Kalynyants and G. V. Rzhechitskaya, *Spirtovaya Prom.*, 1958, **24** (3), 6.
[139]M. E. Aerov, G. L. Motina and M. M. Potarin, *Zhur. Priklad. Khim.*, 1957, **30,** 1100.
[140]S. L. Venkiteswaran, *J. Sci. Ind. Res.*, 1957, **16A,** 216.
[141]E. Pastonesi and M. Avanzi, *Chim. & Ind.*, 1957, **39,** 897.
[142]H. E. O'Connell, *Trans. Am. Inst. Chem. Engrs.*, 1946, **42,** 741.
[143]D. J. Simkin, C. P. Strand and R. B. Olney, *Chem. Eng. Prog.*, 1954, **50,** 565.
[144]A. P. Colbourn, *Ind. Eng. Chem.*, 1936, **28,** 526.
[145]L. Tariel, *Génie Chim.*, 1957, **77,** 174.
[146]J. Marek, *Collection Czech. Chem. Communs.*, **21,** 1560.
[147]*Idem, Chem. Listy*, 1956, **50,** 1555.
[148]*Idem, Ibid.*, 1954, **48,** 971.
[149]*Idem, Ibid.*, 168.
[150]*Idem, Ibid.*, 1955, **49,** 1756.

New centre for European chemical industry

For a number of years the directors of the associations of chemical manufacturers in Western Europe have found it useful to meet from time to time to examine together questions of common interest. The Austrian, Belgian, British, Dutch, French, German, Italian, Swedish and Swiss chemical manufacturers' associations have decided to improve their collaboration and contacts by setting up a Centre Européen des Fédérations de l'Industrie Chimique (C.E.F.I.C.), the secretarial services of which are entrusted to the Swiss Association in Zurich.

C.E.F.I.C. is a working agency of the directors and will be responsible for organising their meetings and for the exchange of information. Contact with the Centre will be solely through the directors of the member countries.

Guide to British instruments

An illustrated directory of scientific and industrial instrumentation, published recently, gives a guide to: associations allied to the instrument industry; British Standards Specifications; consultants and engineers for instrumentation schemes; manufacturers of prototypes and small batches; instruments and components with manufacturers; addresses of manufacturers and their overseas agents; and selected trade names.

A glossary in French, German, Spanish and English, manufacturers' announcements and advertisements are included in further sections of this directory, which comprises 600 pages and is published by the United Science Press, London, in co-operation with the Scientific Instrument Manufacturers' Association of Great Britain. Price, two guineas.

Distillation Research and Industry's Needs

The Distillation Panel set up by the Association of British Chemical Manufacturers and the British Chemical Plant Manufacturers' Association has now issued its report, pointing out the directions in which existing knowledge of distillation processes is inadequate and recommending some profitable lines of research to be undertaken by the universities with the sponsorship of the two Associations. Here is a summary of its findings.

IN choosing the subject of distillation as the first target of its efforts to see that the advances in research at university and other research centres are harnessed to the needs of industry, the A.B.C.M./B.C.P.M.A. Chemical Engineering Research and Advisory Service picked on an operation which has been practised widely for hundreds of years, and about which a great deal is already known. But, as the report points out, distillation is such a fundamental operation and so much capital is invested in distillation equipment, that even minor economies arising from better design are important. In addition, the problems in distillation become increasingly difficult as the range of products being distilled is extended. This has already been recognised by the American Institute of Chemical Engineers, which in 1954 inaugurated a research programme (recently completed) in distillation at three American universities.

The Distillation Panel decided that the aspects of distillation which required more immediate attention were the physical properties of components, mass transfer in distillation systems, tray and packing efficiency, and the instrumentation and control of distillation. It is observed that, now that automatic computers are coming into common use, there is less need for developing short-cut calculation methods for estimating theoretical trays or transfer units. The design of new types of distillation trays has also become a less urgent need; rather there is a need at present for more information about the mass-transfer performance of existing designs.

It was decided that it was not necessary to sponsor research involving large-scale equipment (*e.g.* large-diameter columns), such investigations being more suited to industry.

Prediction of physical data

The report cites references to show that, for all physical properties of single compounds of interest in distillation, calculation methods are available for their prediction in the absence of experimental data, although not all of the methods appear to have been adequately tested on the properties of known compounds.

It was considered whether any of the companies represented in the survey have any special knowledge in this field of physical properties. Limited investigation indicates that no advances have been made over the methods given in the literature, except that one company has carried out a fairly elaborate testing of published methods and has concluded that the methods available are of very limited accuracy particularly when, for example, the compound contains polar groups. No company appears to have made a complete systematic study of the subject in order to recommend the best methods to use for any particular physical property, or for any particular type of compound, and in general it appears to be left to the individual plant designer to use whatever methods he may decide are appropriate for this purpose.

While there is therefore a possible field of investigation into new methods, and perhaps more important a possibility of carrying out a careful and critical survey of known methods, it is not felt that the sponsoring of such work by the panel would be justified. In any case, the actual measurement of the required property of a compound is often not difficult.

For binary systems, by making certain assumptions, a number of integrated forms of the Gibbs-Duhem relationship have been developed and, in addition, there are some purely empirical equations. None of these, however, is capable of predicting vapour/liquid equilibrium relationships in the absence of certain experimental data, and their main use is for extrapolating from such data as may be available, and hence extending its usefulness. For systems of more than two components, the methods available are even more limited, and again no methods are known for predicting the vapour/liquid relationship of non-ideal mixtures in the absence of experimental data. This subject is of such great importance for distillation calculations that there is a strong case for sponsoring further work in this field of calculating vapour/liquid equilibrium data and, for example, of predicting the formation of azeotropes and their composition.

Mass transfer in distillation

There is growing interest in the study of distillation as a mass-transfer process. This receives impetus from the inadequacy of the over-simplified or empirical methods available for estimating the efficiency of bubble trays and the H.E.T.P. of packings. The processes are complex and involve many factors, but research could throw further light on the mechanism of transfer and could lead to an improvement in the precision of design.

In view of the greater practical interest in vapour/liquid contacting devices of the bubbling type, the report limits its survey of this subject to plates, although similar problems exist with other contact devices. The chief lack of knowledge is on transfer performance, usually given in terms of point efficiency, Murphree plate efficiency and overall plate efficiency.

Frothing affects transfer performance and, while there is an extensive literature on the formation of stable foams, there is little on the mechanism of froth formation of the type encountered in distillation. There is evidence that, although pure components do not produce froth, mixtures of liquids of widely different surface tensions froth readily. Quite apart from its effect on the transfer area, a knowledge of frothing is of importance in deciding design features such as tray spacing and downcomer size.

Liquid/vapour contacting devices

The report differentiates between four main groups of contact devices: (*a*) packing in a wide variety of forms, (*b*) bubble-cap and sieve trays, (*c*) newer devices in which the passage of vapour and liquid takes place through

the same openings, *e.g.* the *Turbogrid*, *Kittel* plates, *Spraypak*, etc., and (*d*) equipment in which liquid/vapour contact is obtained by mechanical means.

The Panel points out the need to extend the scope of correlated knowledge to include industrial-scale packed distillation columns. This could be done by collecting as much as possible of the unpublished information which may be available in industry, digesting this and comparing it with published information on smaller columns, finally correlating it and putting it into a form suitable for design purposes. On tray columns, it is pointed out that, in contrast to the mass of detailed work which allows the calculation of the permissible loading of a column with considerable accuracy, there is very little known of the mechanism of contact of liquid and vapour, particularly under the dynamic conditions which exist in a fractionating column. There is no reliable method available for predicting accurately the efficiency of a column as a contacting device, or even for predicting the effectiveness of operation with one system when the performance of another is known. This constitutes a very large and fruitful field for research in which the Americans have been particularly active.

Of group (*c*) devices mentioned above, it is concluded that there is insufficient satisfactory data of a comparative nature available at the moment to enable a general and useful comparison of the various examples of this type of device to be made. It is possible that the best method of increasing the knowledge in this field will be by work carried out by the manufacturers or originators of the devices themselves.

The applications of mechanical contacting appear to be somewhat specialised. The main advantage could be in fractional distillation under low pressures by providing adequate contact with low pressure drop. Such advantage can only be obtained by invention and development, involving considerable financial outlay.

Measurement and control

Controls for distillation systems must be designed for stability of operation and it is therefore necessary to be able to forecast the responses of the column to transient disturbances. Some investigations on transient behaviour are progressing, but much more must be done.

Efforts could also be made to arrive at an approach to calculation based on the theories of mass and heat transfer and fluid flow in a column. To this end it is most desirable that investigations of the mechanism of mass transfer should include transient disturbances as well as steady conditions.

For quality measurement, it is customary to rely on temperature as an indirect measure. However, the most effective control of quality is ultimately dependent on the provision of instruments able to measure a small concentration of impurities accurately. There is still a need for considerable development of continuous analytical instruments for plant use.

In batch distillation, the problem of control may be stated, for a fixed boil-up rate, as the regulation of the rate of offtake throughout the batch so as to obtain the maximum overall rate of output of required products, allowing for return of any intermediates. There is no evidence that this problem has ever been solved.

BACKGROUND TO THE DISTILLATION PANEL REPORT

The Distillation Panel was formed in 1957 as an offshoot of the chemical engineering advisory service operated jointly by the A.B.C.M. and the B.C.P.M.A. These two associations have agreed to be responsible for the financing of the six research projects recommended in the report. The report was completed in May 1958, but hitherto its contents have been made known only to the companies and organisations which assisted in the panel's investigations. It has now been released for general publication.

The subject of distillation was chosen as the first subject for examination after a questionnaire issued to member firms of the A.B.C.M. and B.C.P.M.A., intended to determine in which fields 'gaps' in basic information appear to lie, revealed that information on distillation was most in demand. Already a second panel has been at work in the field of liquid/solid separation; panels on other subjects will follow as soon as a genuine need for basic knowledge in other fields has been established.

The A.B.C.M./B.C.P.M.A. advisory service was created after the two associations had separately canvassed the views of their members about the view of the Cremer Committee (set up in 1951 to review existing needs and facilities for chemical engineering research) that a specially created or adapted central research organisation should be brought into being. The results of this canvassing, and subsequent consideration, led the two associations to the conclusion that they could not consider the setting up at that time of any central form of research organisation but that they should establish an advisory service to help members with chemical engineering problems and to report, from time to time, on 'gaps' in chemical engineering knowledge.

Recommended lines of research

The report concludes by describing six subjects recommended for attention by university research laboratories, as follows:

(**1**) There is a need to develop an integrated form of the Gibbs-Duhem equation which would have complete general applicability. It is hoped that any general equation developed may give a lead to the more fundamental problem of prediction in the absence of any experimental data. For example, it has already proved possible to establish some correlation between the van Laar constants for a homologous series of compounds. Any such relationship found might well require testing by experimental work.

Another approach to the problem might be the intensive study of a particular system or number of systems including the measurement of all the physical properties of the components likely to have some influence on the vapour/liquid equilibrium, in the hope of establishing a relationship between this equilibrium and one or more of these properties.

In general it would be desirable for the programme suggested above to work initially on two-component systems. There is, however, also scope for work on the prediction of vapour/liquid equilibria of three-component systems from data available on the three binaries and again this is essentially mathematical work in the first instance.

(**2**) The accurate prediction of plate efficiencies in tray columns from the physical properties of the fluids and geometry of the column is a highly desirable design objective which is not yet achievable. The formation of gas-liquid interfaces across which heat and mass transfer can occur is such a basic feature in distillation that any attempt to analyse the fundamental mechanism must involve a study of the surfaces formed between liquid and vapour. It is suggested tentatively that the effect of the geometrical parameters in, for example, bubble-cap and sieve plates on bubble growth, frequency, size and shape (including the effect of coalescence) warrant further study. These factors would need to be investigated with systems of different physical properties.

(**3**) In dealing with industrial distillation problems there is an urgent need for more accurate and logically based design methods. The designer relies largely on existing performance data or, in their absence, resorts to conservative guess-work. The literature contains a number of attempts to

assist in the selection of plate efficiency. The research proposed concerns the effect of the physical properties of the system on plate efficiency, in particular as it affects the mass-transfer mechanism. A sound fundamental appreciation of this aspect, together with associated work on the formation of surfaces during bubbling and on the production of froth, should enable progress to be made towards the ultimate objective of developing satisfactory design methods for predicting efficiency from the physical constants of the fluids.

(**4**) There is a need for further quantitative study of the physical factors affecting the formation of short-lived froths such as are formed when a gas or vapour is bubbling through a liquid. In addition to investigating the influence of liquid composition the study should also be concerned with the influence of heat transfer and mass transfer, between the gas or vapour stream and the liquid, on the degree of frothing. An attempt should be made to correlate the degree of frothing in terms of easily measured physical quantities.

(**5**) Research on packed columns should be devoted primarily to the correlation of performance data on packed columns with particular reference to data on columns of 6-in. diam. and greater.

(**6**) It has been seen that there is a great need for further study of the transient behaviour of distillation columns in response to disturbances. It is recommended that an investigation should be made of as many existing plant-scale columns as possible for this purpose.

INDUSTRIAL PUBLICATIONS

Titanium and its alloys can withstand attack by many chemicals and I.C.I. Ltd., Imperial Chemical House, Millbank, S.W.1, point out its advantages as a constructional material, illustrating various fabrications in the metal in their revised publication, 'I.C.I. Titanium for Chemical Plant.'

Electrodes. The English Electric Co. Ltd. have developed their *Hermees* electrodes for the fast welding of heavy sections and restrained joints in mild steel, medium-high tensile and carbon and alloy steels. Their properties and the recommended welding technique are mentioned in publication WA/141, obtainable from the company's Welding Electrode Division, Clayton-le-Moors, Accrington.

Refractory material which can be applied with a cement gun, *Tri-Mor Dense Guncrete*, and can withstand temperatures up to 1,300°C. is publicised in leaflet RD85 from Morgan Refractories Ltd., Neston Wirral, Cheshire.

Industrial vacuum cleaner. Sturtevant Engineering Co. Ltd. give details of their *Six-X-Three* model, which is claimed to fill the gap between the small and large industrial machines, in a publication obtainable from Southern House, Cannon Street, London, E.C.4.

Electro - mechanical brakes by Lancashire Dynamo & Crypto Ltd., St. Stephen's House, Victoria Embankment, Westminster, S.W.1, are shown in many of their applications in a pamphlet released by the company.

Steam turbines. Sectional arrangement drawings of complete turbines and sections are reproduced in a 40-page publication from the English Electric Co. Ltd., Steam Turbine Division, Rugby. Details of manufacture are illustrated together with installations varying from 10 to 100 mw. units.

Careers with the United Steel Companies Ltd. are the subject of three publications, one of which describes the opportunities for graduate scientists and engineers in research and development. Another outlines opportunities for arts as well as science graduates in managerial, research and commercial capacities. The last concerns the training of student apprentices who have passed the G.C.E. at advanced level. Obtainable from the recruitment officer at 17 Westbourne Road, Sheffield 10.

Oxygen steelmaking is the subject of a publication which sets out to review the present-day situation and to provide some kind of historical perspective. The oxy-Thomas, L.-D. and *Kaldo* processes are discussed and illustrated in a 28-page brochure from Head Wrightson & Co. Ltd., 20 Buckingham Gate, London, S.W.1.

Zinc dust in paints is the subject of a publication from the Zinc Development Association, 34 Berkeley Square, London, W.1. Comprehensive information is given about the uses of zinc-dust paints and there are photographs of many of their applications.

Gasholder. Operating principles of the Wiggins low-pressure, dry-seal gasholder are described and illustrated in a publication by Ashmore, Benson, Pease & Co., Parkfield Works, Stockton-on-Tees. Constructional features are outlined and a question-and-answer summary is included.

Lighting terms which are not always fully understood are explained in technical bulletin 34, published by Victor Products (Wallsend) Ltd., G.P.O. Box No. 10, Wallsend-on-Tyne. Details in booklet form of the company's range of lighting fittings are also available on request.

Polyvinyl acetate. Vinyl Products Ltd., Butter Hill, Carshalton, Surrey, with their Monograph No. 1, aim to outline the general characteristics of polyvinyl acetate emulsions without reference to individual grades. The 36-page publication deals with their manufacture, modification and processing and also with the properties of the emulsions and their films.

Chemical plant manufacture. The British Chemical Plant Manufacturers' Association, 14 Suffolk Street, London, S.W.1, offers a booklet describing the services of the association to chemical plant manufacturers and users. It is primarily intended for the information of firms enquiring about membership, and may be had on application to the secretary.

Controls. Details of self-contained and remote-set controllers, miniature panel, indicating, and ratio control stations are given in various technical publications by Sunvic Controls Ltd., 10 Essex Street, London, W.C.2.

Factories Acts. The United Steel Companies, Westbourne Road, Sheffield, have revised and brought up to date their summary issued in 1945. This reference booklet, in the language of the layman, brings together the main provisions of the Acts as applying to the iron and steel industry.

Reducing the Cost of Corrosion

By Sir Owen Wansbrough-Jones, K.B.E., C.B.
(Chief Scientist, Ministry of Supply)

It was appropriate that the Corrosion Exhibition 1959 *should be opened by the head of one of Britain's biggest scientific organisations which, amongst other tasks, is vitally concerned with the protection of equipment from corrosion. Here are some points from Sir Owen's opening address:*

CORROSION as a subject has fascinated scientists for well over 2,000 years while I suppose its consequences have irritated engineers and users for even longer. And even now there is much of the science of it that we do not understand and I think there are many applications of scientific knowledge that can be put towards its control that have by no means been fully exploited. There are, of course, scientific societies and groups primarily devoted to its study and I need not mention them by name. This Exhibition, organised by the Leonard Hill Technical Group through their publication *Corrosion Technology*, is a counterpart on the trade side to what the corrosion groups of the scientific societies do by way of research and development and it is very much to be welcomed, providing as it does a shop window which should be of great help in the needed spreading of knowledge on methods of preventing corrosion.

Benefits of corrosion technology

The cost to the world and to individual countries of corrosion in all its aspects is very hard to assess. Indeed, attempts to provide figures for it seem to have been peculiarly fascinating, perhaps in part because it is so difficult to check the result. Recently I was told that the annual loss due to corrosion in India is put sometimes at £40 million per year and sometimes at £100 million. No doubt it lies somewhere between the two. For this country the figure of £600 million per year, 2s. in the £ on the standard rate of income tax, has been widely quoted, though I personally find it a slightly unbelievable one on some assumptions. But, unlike India, which has, at least from the corrosion point of view, a benign climate, in the North at least, we have a hideous one, moist, an extensive coastline and still regrettably a great deal of atmospheric pollution. In the U.S.A. a figure of $6,000 million has been given and if the net saving if corrosion was totally abolished would be far less, here is a really significant saving that should be of national concern as well as of obvious primary concern to corporations, companies and individuals who would be the direct beneficiaries.

And yet I personally wonder whether it is this direct saving in money that has to be our first concern. Putting it very crudely, the corrosion of plant, ships or equipment, though it does terminate life sometimes prematurely, is not necessarily the only reason for such termination. Obsolescence in other ways might equally have caused it and I think that is a main reason why the estimates of the cost of corrosion may be a little wide of the mark. I am not sure that the real damage done is not on a more subtle count—losses in reliability, extra costs in maintenance, extra wear in mechanical equipment and so on. Certainly so far as my own Ministry is concerned it is in fields like this that we feel ourselves particularly vulnerable.

It is perhaps this aspect of corrosion, the maintenance of reliability, in detail, that the scientist can next tackle best.

Cutting the cost

In the meantime let us concentrate on the task in hand which is to reduce by all means possible the economic losses that corrosion costs us by the three obvious consecutive means, first by securing the increase in basic scientific knowledge that is required, second by exploiting this knowledge so that the scientific results may become commercially applicable, and third to make known to all concerned and in the widest possible way this great variety of commercial applications. It is especially towards the third task that this exhibition has so much to offer.

Sir Owen Wansbrough-Jones making his official opening speech at the Corrosion Exhibition. Behind him (*left*) is Mr. W. Leonard Hill, chairman of Leonard Hill Ltd., and, in the background (*left*), Capt. G. B. Bonds (Seaguard Ltd.) and (*right*) Dr. F. Wormwell (National Chemical Laboratory).

Exhibition Review

Some 11,000 *visitors from all parts of the world attended the Corrosion Exhibition* 1959, *held in London recently by the Leonard Hill Technical Group through its monthly journal* Corrosion Technology. *Here we present some examples of the exhibits that were on view.*

Shell vapour-phase inhibitor protects precision metal parts.

Corrosion-resistant metals

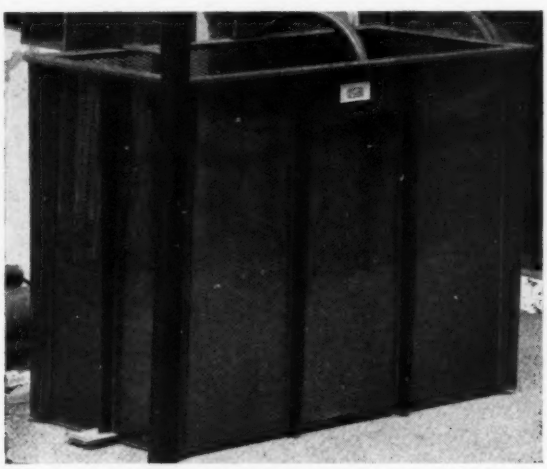
Titanium in the chemical industry was the main theme of the I.C.I. Metals Division stand and a working exhibit showed how, by the use of an impressed positive potential, the corrosion resistance of titanium can be increased to cover an even wider range of corrosive liquids. Examples of platinum-coated titanium electrodes were also on display. The I.C.I. investigations on the use of these electrodes in electrochemical processes were discussed in CHEMICAL & PROCESS ENGINEERING, February, page 41.

The stand provided evidence that, apart from titanium, the Division is now producing zirconium on a commercial scale, and is also doing considerable research and development work on the ' new ' metals such as vanadium, niobium and beryllium.

Linings in special ebonite

Nordac Ltd. made a display of their *Vulcoferran* lining materials for steel and cast-iron surfaces. No. 35 grade is suitable for resisting the alternating attack of acid and alkali and withstands a higher temperature than the standard No. 31 grade, giving service at up to 120°C. *Vulcoferran*, a special type of ebonite, has a very high degree of adhesion due to chemical reaction with the base metal, and is also suitable for vacuum conditions. It may be applied to new or existing vessels and equipment and is available in various grades for special applications. It is particularly resistant to sodium and potassium hydroxide up to 110°C. and withstands ammonia at all concentrations. The material is also suitable for use with practically all salts in weak or strong solutions at temperatures up to boiling point. It is unsuitable for certain oxidising agents, particularly such acids as nitric and chromic. It can, however, be used for cold nitric acid up to 5% concentration.

Nordac fabricate complete tanks and vessels of metal lined with rubber or lead in their own shops.



Chemical tank of ' Cobex ' rigid vinyl made by BX Plastics Ltd. and laminated with expanded metal.

Treatment of metallic surfaces

Research on a number of problems connected with the protective treatment of metals was illustrated on the stand of Metallic Surfaces Research Laboratories Ltd. Four examples of current research included the protection of metals against high-temperature oxidation, the effect of high-frequency heating on diffusion, the protection against corrosion of ultra-high-tensile steels, and the vacuum deposition of metals.

The same stand illustrated examples of improved chromising processes offered by Metallic Surfaces Developments Ltd. Data were presented to show that the chromium-rich surface formed on steels by chromising (*e.g.* by the *Arkrom C* process) has excellent resistance to oxidation at elevated temperatures, comparable with that of a 30% chrome iron.

Industrial stoneware and porcelain

Exhibits by Doulton Industrial Porcelains Ltd. included a new range of high-duty porcelain with tensile strength up to 7,000 p.s.i. and excellent abrasion-resistant qualities, while some special materials have high thermal-shock resistance. Stoneware and porcelain containers on show varied in capacity from a few c.c. to 2,000 litres; these are used for storing, marketing and transporting acids, alkalis, foodstuffs, essences, chemicals, etc.

Various designs of ceramic piping included Doulton fixed flanged piping which has no cement joint and ensures ease of installation and re-siting. It is suitable for working pressures up to 100 p.s.i. Cyclone nozzles, lining bricks, paddle blades, grinding balls and ball mills represented examples of abrasion-resisting porcelains.

Among the porous ceramics were materials of pore sizes from approximately ½ to 750 microns. Both the standard and corundum qualities were exhibited, the latter having exceptional mechanical and thermal characteristics.

A variety of complete filter units were displayed

including units constructed in rigid PVC, ebonite-lined mild steel, stoneware, *Pyrex* glass and stainless steel.

Glassed-steel chemical plant

Examples of British *Pfaudler* glassed-steel equipment for the chemical industry were shown by Enamelled Metal Products Corporation (1933) Ltd. These included a 20-gal. reaction vessel, representative of a standard series ranging from 1 to 2,000 gal. A 5-gal. open container, a glass-lined flush valve and samples of glass-lined pipes and fittings also appeared on this stand, all being lined with *Pfaudler* acid- and alkali-resistant glass enamel.

Protection of buried pipes

The anti-corrosion protection of buried pipelines was a feature of the Fibreglass Ltd. stand, while examples of the industrial applications of *Fibreglass*-reinforced plastics were also given. Continuous pipelining is now widely used for constructing oil, gas or water pipelines. The pipe is strung alongside the ditch, welded into a continuous length and then cleaned and primed ready for coating. *Fibreglass* inner and, if necessary, outer wrap is applied by a continuous coating and wrapping machine tracked to the pipe. *Fibreglass* pipewrap tissue has been used on projects ranging from single-coat/single-wrap, through single-coat/double-wrap to double-coat/double-wrap. The moving exhibit showed *Fibreglass* pipewrap tissue used on major oil pipeline projects.

An enlarged photograph showed hoods moulded in F.R.P. over chemical process tanks giving off corrosive fumes. There were also examples of moulded tanks, pipework and a length of corroded steel pipe repaired with *Fibreglass* reinforcement and resin, for which kits are now available.

Epoxy resins

Shell Chemical Co. Ltd. showed their *Epikote* epoxy resins, used in the production of chemically resistant surface coatings and reinforced-plastics compositions which are not subject to corrosion. New products on this stand included *Carina* PVC and *Carlona* polythene (Ziegler-type, high-density polymer), used in the manufacture of pipe for carrying water and chemicals of many types; in rain-water guttering; in the coating of metal; and, generally, in the replacement of, or protection of, materials which are subject to corrosion.

Shell vapour-phase inhibitor represents a new technique in corrosion prevention, either in the form of crystals or impregnated paper. Metal products are protected by an envelope of vapour—no oils, greases, hot dips or other expensive moisture-proof barriers being required. No cleaning need be carried out when the articles are removed from packages.

Another company, Ciba (A.R.L.) Ltd., who demonstrated the uses of *Araldite* epoxy resins for protection against corrosion, have developed a new formulation consisting of a heavily filled resin for use as an industrial flooring. The resin, used in conjunction with a hardening agent, is easily applied, and has excellent adhesion to concrete, metals and wood. It is also claimed to have outstanding resistance to wear and abrasion and to be unaffected by chemicals.

Among the *Araldite* surface-coating resins was a new, solvent-free system enabling coatings of up to 0.020 in. in thickness to be applied in one operation. It is a cold-curing system and is unaffected by high atmospheric humidity during the curing period. This type of coating is used for protecting and strengthening the lagging of pipes in chemical plants.

Control of corrosive fluids

A stop valve suitable for controlling the flow of almost any fluid and gas up to a maximum temperature of 100°C. was shown by Meynell & Sons Ltd. The upper part of the rubber valve is so shaped that the movable parts of the stop valve remain isolated from the liquid, eliminating the need for packing glands. The design of the clack and clack seat and the complete elimination of pressure on that part of the clack separating the fluid controlled from the working mechanism is claimed to ensure an extraordinary long period of service without need for replacement. The valve is available either screwed or flanged and is stated to be suitable for all liquids including acids, corrosive fluids and brine. The *Rayon-Patent* stop valve is also suitable for use in absolute vacuum.

Closure of the *Rayon-Patent* valve is by means of a rubber clack which is moulded integral with a gasket which separates the line fluid from the working mechanism; the design of the clack is such that, even if after long usage, the gasket should rupture, the valve can still be closed off.

Plastic linings and coatings

Heat-cured resins including phenol formaldehyde, phenol epoxy and urea epoxy resins are used in linings and coatings displayed by James Lithgow (U.K.) Ltd. One example of the applications of *Calvinac* plastic lining was a mild-steel, 14-ft. manifold made of 3-ft.-diam. sections, while another was given in two elevator buckets exhibited on the stand, both after having handled hot sugar-beet pulp for two 'campaigns.' The uncoated bucket was seen to be holed and badly corroded while the *Calvinac*-coated specimen was intact.

These materials also have uses in the lining of pipes and spraying techniques make it possible to spray the internal surfaces of 35-ft. lengths of pipe in diameters down to 1½-in. bore.

Corrosion-resistant cements

F. Haworth (A.R.C.) Ltd. exhibited two aspects of their activities: (*a*) as specialist contractors in anti-corrosion work, and (*b*) as suppliers of materials to resist acid and alkali attack. These include a range of cements such as:

Improved Grey (sodium silicate type). A general-purpose cement resistant to medium concentrations of most of the common organic and inorganic acids except hydrofluoric. Recommended where the concentration lies between 3 and 15%. Suitable for high temperatures. Unsuited to aqueous solutions, alkaline conditions and crystal-forming liquors.

Double White (potassium silicate type). A similar cement to the above, but generally employed where the acid concentration is above 15% and for the very dilute liquors. Adaptable for high temperatures but not recommended for crystallising solutions, continuous water washing or alkalis.

Rubex (rubber latex type). A dual-purpose cement for use in the presence of most acids and acid gases up to 5% concentration at temperatures up to 60°C. and also alkaline solution up to 15% concentration. Has remarkable adhesion and will withstand abrasive conditions.

Rubex (*B*) (rubber latex type). A special grade of latex cement which will withstand mild chemical conditions. Produced mainly as a tile adhesive to avoid 'lifting' troubles. Can be used as a waterproof membrane.

Essar (*W*) (furane resin type). General-purpose cement for resisting alkalis, non-oxidising acids and practically all solvents. Completely non-porous and unaffected by water, oils, fats, greases, etc. Working temperatures up

▲At the Corrosion Exhibition: N. R. Graesser, of James Lithgow, with Sir Owen Wansbrough-Jones; W. G. Norris (Leonard Hill Technical Group) on the right.

◀W. Leonard Hill talks to S. J. Reason and A. E. Norman of Nordac Ltd.

▼On the B.X. Plastics stand are (*left to right*): C. M. Hall, K. W. Dowell and C. A. Britton.

to 190°C. Not recommended for hot oxidising acids or hydrofluoric acid.

Essar (*B*) (furane resin type). A variation of the above cement with exactly the same properties, but which will, in addition, withstand hydrofluoric acid. Recommended for the higher concentrations of hot caustics.

Ennar (cashew resin type). A dual-purpose cement, with particular advantages on the alkaline side. Very adaptable for membranes between outer shells and special linings. Not recommended for large areas of vertical brickwork but suitable for floorings.

Epilon (epoxy resin type). The latest development in resin cements and claimed to be the nearest approach so far to a universal cement. Possesses high resistance to acids, alkalis, salts and solvents. Has tremendous adhesion and negligible shrinkage. Can be used for bedding and jointing, as a pointing medium, or as a rendering to tanks, floors, etc. Particularly suitable for jointing stoneware pipes.

Synthetic rubbers

This was the first British trade show to feature the complete range of synthetic rubbers of the Du Pont Co. (United Kingdom) Ltd. and a new fluoroelastomer, *Viton*, which will stand temperatures up to 450° even in the presence of many oils and chemicals, was shown along with neoprene general-purpose material and *Hypalon*, a rubber with high resistance to chemicals, especially those which are highly oxidising.

Typical applications of these elastomers including tank and pipe linings, valve parts, gaskets, ' O ' rings and hoses were shown, as were also coatings based on these materials. An item of special interest was a neoprene-lined heat-exchange conveyor box.

Corrosion research

The stand of the National Chemical Laboratory, D.S.I.R., gave visitors an opportunity of learning something about the experiments carried out by the Corrosion of Metals Group and the sort of advice that the laboratory can give about corrosion problems. One subject to which considerable attention has been given is the corrosion of metal pipes or dividing walls in heat-exchange systems. Experimental water circulating systems in use at N.C.L. have been designed to investigate the effects of water composition, speed of flow and temperature on the corrosion of metal pipes. This should make it possible, from a knowledge of the composition of a water, to estimate its corrosiveness. For corrosive waters, different methods of water treatment will be tried in the laboratory systems before being applied in large industrial systems. By way of contrast, an extremely sensitive means is being used to find out how compounds such as chromates prevent corrosion of immersed steel when they are added to water in sufficient amounts. This involves the use of radioactive tracer in the form of sodium chromate containing radioactive chromium. Complete protection from corrosion is given by a minute amount of chromium compound on the actual steel surface—it forms part of an oxide film that is too thin to be seen—but it can be measured by exposing the protected specimen to a Geiger counter.

Chemical plant in plastics and metal

Various items of chemical plant made from *Cobex* (rigid vinyl) and *Cobex* expanded-metal laminates were displayed by BX Plastics Ltd. There were also various exhibits of chemical plant equipment fabricated by leading manufacturers in this field. Plant made from *Stelvetite* plastic-coated steel was also on view.

ORDERS AND CONTRACTS

A number of important contracts for the supply of plants and processes to the U.S.S.R. have recently been announced by British companies and the trade delegation of the U.S.S.R. in the United Kingdom. Among those who have concluded contracts with the Soviet importing trade organisation V/O Techmashimport, Moscow, are:

Prinex Ltd., a subsidiary of Courtaulds Ltd., who are to supply complete plants and technical processes for the manufacture of viscose rayon tyre cord, acrylic staple fibre and cellulose acetate yarn. The total sum involved is about £15 million.

Dunford & Elliott Process Engineering Ltd., who are to deliver to the U.S.S.R. a rotary-louvre carbon black drying installation. This installation will incorporate dust-collection equipment and control equipment supplied by Dunford & Elliott's subsidiary companies, Thermix Industries Ltd. and Lindars Automation Ltd., respectively.

Nordac Ltd., who have concluded a contract for the supply of sulphuric acid concentration plant to the value of £90,000.

The plant will have an output of 24 tons/day of 78% sulphuric acid, the starting acid being an effluent of about 16% sulphuric acid. Heat for evaporation will be supplied by combustion of heavy fuel oil.

*

A contract, worth more than £300,000, to supply and erect six *Petro-Chem Iso-Flow* furnaces at the new Esso oil refinery in the Botlek area, near Rotterdam, has been awarded to Birwelco Ltd. The furfurnaces are for the *Powerformer* and the *Hydrofiner* units now being constructed at the refinery. They range in size from 20 million to 90 million B.Th.U./hr. and the largest is about 27 ft. in diameter and 138 ft. high.

The *Hydrofiner* furnace is of novel construction and comprises three independent coils in one shell with a total duty in excess of 55 million B.Th.U./hr. The reheat furnaces in the *Powerformer* train are also housed in one shell.

*

A £300,000 order has also been placed with Birwelco Ltd. and their subsidiary, Brown Fintube (Great Britain) Ltd., for the supply of six *Petro-Chem Iso-Flow* furnaces and tank heaters at the Rio Duque de Caxias refinery, Brazil, for Petroleo Brasileiro S.A. Here, four of the furnaces will be required to heat hydrocarbon vapours and hydrogen to temperatures up to 1,000°F. and will operate at pressures up to 700 p.s.i. The actual duty on the furnaces varies, but the maximum is approximately 70 million B.Th.U./hr., whilst the smallest is 10 million B.Th.U./hr. The large furnaces are designed for high efficiency using a separate convection bank, the largest furnace being 20 ft. in diameter and 100 ft. high to top of stack, and one of them incorporates a separate steam superheater.

*

A contract has been placed by Siemens Edison Swan Ltd. with Kestner Evaporator & Engineering Co. Ltd. for an installation to neutralise the acid effluent from their plating shop.

The installation, to be installed at Siemens' works at Woolwich, will consist of four continuous neutralising units with the necessary ancillary plant. The whole will be in *Keebush*, and will include acid liquor pumps.

Orders for equipment, amounting to $U.S.125,000, for copper mines in Turkey have recently been received by Head Wrightson Stockton Forge Ltd. from the Turkish Government Agency E.T.I. Bank.

During the early part of the second world war Britain supplied much of the equipment for the Morgul copper mines in Eastern Turkey. For this project Head Wrightson Stockton Forge Ltd. were responsible for providing classifying, grinding and drying equipment in addition to a number of copper converters. Financed as part of the American I.C.A. dollar arrangements, large quantities of spares have been dispatched to Turkey.

*

A record order for laboratory glassware assemblages, which are constructed so as to fit into laboratory bench drawers or cupboards, is announced by Quickfit & Quartz Ltd. The order is for 620 sets, comprising nearly 10,000 pieces, for the National University of Mexico in Mexico City.

Company News

Q.V.F. Glastechnik, of Wiesbaden, German subsidiary company of Q.V.F. Ltd., have almost doubled their total annual sales of industrial glassware in Germany during the last financial year —from £62,638 in 1957 to £119,256 in 1958.

*

I.C.I. is to extend its polyolefine activities with the introduction of a new polypropylene plastic under the trade name *Propathene*. An agreement has been signed whereby I.C.I. acquires a licence under the Montecatini and Montecatini/Ziegler U.K. patents covering the production and use of this new plastic material.

A new plant to manufacture *Propathene* is being constructed at I.C.I.'s Wilton works in North Yorkshire. It will bring I.C.I.'s total polyolefines capacity for *Alkathene* and *Propathene* to over 100,000 tons p.a.

Johnson, Matthey & Co. Ltd. have acquired an interest in the Italian precious-metal refining and manufacturing company, Metalli Preziosi SpA. of Milan. This company has its principal refineries and production centre in the new industrial zone of Paderno Dugnano, near Milan. A new, comprehensive precious-metal metallurgical and chemical production plant will shortly be completed there.

*

Plans for doubling Union Carbide's polythene production in the United Kingdom involves the augmentation of existing facilities at Grangemouth, Scotland, by another unit scheduled to produce 30 million lb. p.a. The new unit is expected to be in production by late 1960. Bakelite Ltd., an affiliate of Union Carbide Ltd., will distribute the output of the plant.

As well as the initial polythene plant at Grangemouth, Union Carbide Ltd. is constructing an ethylene oxide and derivatives plant at Fawley, Hampshire, which is expected to be in operation in the last quarter of this year, with a production capacity of 45 million lb. annually.

This latest expansion represents the sixth major investment by Union Carbide Corporation in the European petrochemicals field.

WHAT'S NEW

Plant • Equipment • Materials • Processes

CPE reference numbers are appended to all items appearing in these pages to make it easy for readers to obtain quickly, and free of charge, full details of any equipment, machinery, materials, processes, etc., in which they are interested. Simply fill in the top postcard attached, giving the appropriate reference number(s), and post it.

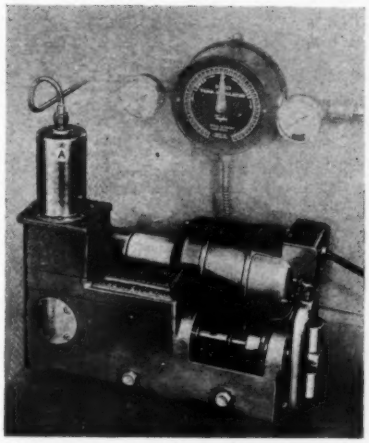
Minerals get a treat

Head Wrightson & Co. Ltd. become licensees in the United Kingdom and the Commonwealth (excluding Canada) for the Swedish *Stripa* process for coal and mineral treatment. Exploitation will be in the hands of Head Wrightson Colliery Engineering Ltd., who will use it in conjunction with the *Stamicarbon* (D.S.M.) processes.

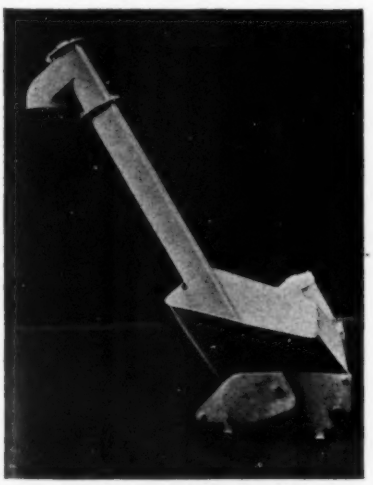
In the *Stripa* process a convenient separating medium (*e.g.* a suspension of magnetite or shale) is fed to a shallow reciprocating trough and the mineral to be treated is added a short distance from the medium feed point. The medium is concentrated to some extent in the trough and conditions are set up permitting quick and accurate separation of a floating fraction and a sinking fraction which are discharged separately at the end of the trough, the cut between them being made by an adjustable splitter plate. The medium solids used can be relatively coarse, and medium recovery systems are therefore very simple.

It seems that the process will be especially useful for separating coal accurately at high densities, and that the separators will have a high capacity. Also, economical plants can be designed embodying both *Stripa* and cyclone washing units and suitable for both ore and coal treatment.

CPE 1250



Metering pump with regulator coupling.



Trolley-mounted elevator.

Mixes as it lifts

A screw-conveyor-type elevator for handling bulk materials, developed by Russell Constructions Ltd., consists of a feed hopper from the base of which two opposed horizontal spirals lead the material into a slightly inclined elevating spiral which propels it to a height of up to 5½ ft. This can be increased to as much as 11 ft. through an easily fitted extension.

The unit, mounted on trolley wheels, is powered by a small electric motor through an infinitely variable torque converter, and is quiet and dust-free in operation. When fitted with a 1½-h.p. motor the range is from 3 to 12 tons/hr. and with ¾ h.p. the range is ½ to 3 tons/hr.

The feed hopper has a capacity of 4½ cu. ft., and its feeding height is 18 in.

The machine, which can be used for mixing two different materials while they are being elevated, can be dismantled for cleaning in a few minutes. All bearings of the spiral units are sealed against lubricant contamination. **CPE 1251**

Automatic control for metering pumps

The 'M' range of metering pumps produced by the Distillers Co. Ltd., developed primarily for the accurate metering of small quantities of fluids, can now be operated with *p*H, temperature, flow and other controls. They are responsive to pneumatic signals of from 3 to 15 p.s.i.g., adjustment of the plunger stroke being carried out by a small, compact bellows motor operating through a mechanism designed to reduce 'hunting.'

CPE 1252

Improved drying of gases

Higher efficiencies at lower cost are claimed for the redesigned range of Holmes-Kemp driers. By the use of four-zone heaters, one in each tower, a considerably higher heat input is achieved and this, together with more effective heat distribution, has resulted in higher desiccant capacities for each size of drier. The makers, W. C. Holmes & Co. Ltd., say it has been found in practice that a drier using the new heaters will, with no increase in the amount of solid desiccant used, remove about 10% more moisture.

The general appearance of the *Oriad* drier has also been considerably improved by enclosing the desiccant towers with a flush-mounted instrument panel. **CPE 1253**

Clad impeller speeds fans

Fans for exhausting corrosive fumes and gases, based on their original 'D' series, are being produced by Sturtevant Engineering Co. Ltd. in conjunction with Acalor (1948) Ltd. They have an all-PVC casing with clad impeller, the impeller and base being of standard design.

It is claimed that this unit has the advantage of safe, high operating speeds, and that greater efficiencies can be obtained in many instances than with the fabricated PVC impeller. An all-PVC fabricated impeller will become available as an alternative.

CPE 1254

The low-down on pipe protection

Pre-formed, semi-rigid, mineral-wool pipe insulating sections are available for insulating underground pipe, including industrial high-pressure steam mains. Suitable for a temperature range of –400 to 1,500°F., they are produced by Stillite Products Ltd. *Stilag* section can be fitted to pipes by unskilled labour in relatively short lengths to facilitate handling on site. The resilience of the material allows of butt joints, which are thermally imperceptible.

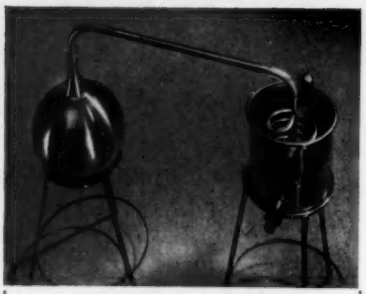
The sections are placed on the pipe with longitudinal joints in a horizontal plane and wired in position or held by lagging staples. U-shaped troughs are suspended from the insulated pipe by non-corroding rods passing through perforations in the troughs. Each trough overlaps and is secured by the support rods to form a continuous trough. Bitumen at a temperature of 200°C. is poured into the troughs to fill all free space and submerge the insulated pipe and the pins.

CPE 1255

Safety suit gets all puffed up

Process workers and engineers who get 'all blown up' about having to work in an atmosphere contaminated by toxic smoke, gas or dust particles can now climb into a pressure-ventilated suit and hood which will make them look more blown up than ever, but which will enable them to move around freely and safely. Such clothing is also useful for operations involving strenuous physical effort in confined spaces, or high ambient temperatures.

Plysu Products Ltd., who have been supplying pressure-ventilated clothing for atomic energy and other specialised industrial operations, are now offering a standard range including complete suits, 'half suits' and transparent hoods of various types. Suits are normally fitted with adjustable non-return valves controlling the rate of air flow through the suit; alternatively, provision for one or more exhaust filters can be arranged. **CPE 1257**



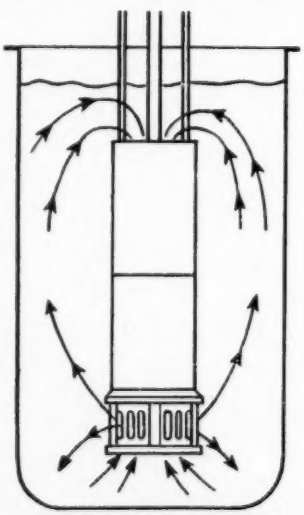
A MYSTERY STILL

We do not know what this still is for, but as it is constructed from pure platinum readers will be able to judge that it must be for the distillation of an unusually corrosive liquid. One of three destined for a Far-Eastern government, it was designed and manufactured by Johnson, Matthey & Co. Ltd. The sphere is 5 in. in diam. and the cooling coil consists of five turns of platinum tube of 0.2-in. bore and 0.012-in. wall thickness.

CPE 1256

Controls furnace temperature

Providing close control of furnace temperature and doing away with the usual variable mains transformer, mains shunt resistance and relay, a new proportional temperature controller is operated by a resistance thermometer, the change of resistance with temperature being used in a bridge system to give a continuously variable current which governs the output of a saturable reactor or transducer. The controller has compensation for mains voltage variations which comes into effect instantly, thereby anticipating the signal from the resistance thermometer and stabilising the furnace current. Makers: C.N.S. Instruments Ltd. **CPE 1258**



How the 'Rotamix' mixes.

Makes a steady job of mixing

High-speed mixing for the production of solutions, dispersions and emulsions is possible with the French-manufactured *Rotamix*, distributed in Britain by Mill Room Accessories & Chemicals Ltd. The main shaft of the unit works in a top and bottom bearing and the turbine propeller, enclosed in the 'disperser,' is easily removable. Four vertical rods support the bottom bearing and the disperser.

The mixer remains steady during mixing because of its specially designed suspension cage. Special suction shields can be supplied which create a definite circular motion and facilitate the feeding in of resins and pigments.

CPE 1259

Same performance, smaller pumps

Class 'E' insulated motor windings have been introduced to *Monobloc* pumps, enabling Worthington-Simpson Ltd. to offer smaller, lighter pumps in their 1½ to 10-h.p. range which give the same performance as comparable units with class 'A' motors.

The 5-h.p. motor is fitted to a two-stage *Vortex* pump which has a maximum capacity of 520 gal./hr. and a maximum head of 540 ft. depending on capacity. Length of this unit is 2 ft. 1 in., width 9 in., height 1 ft. 2 in. and weight 175 lb. **CPE 1260**

Resistant resin

High resistance to chemicals is claimed for a thermoplastic resin which can be used in coatings for most types of masonry surfaces with no fear of paint failure, even from alkali attacks. This is stated by the makers, Goodyear Tyre & Rubber Co., who say that such coatings offer protection to floors, as well as structural steel, machinery and plant where spillage of chemicals occurs.

Pliolite S-5 is a styrene/butadiene, thermoplastic resin, soluble in aromatic solvents. **CPE 1261**

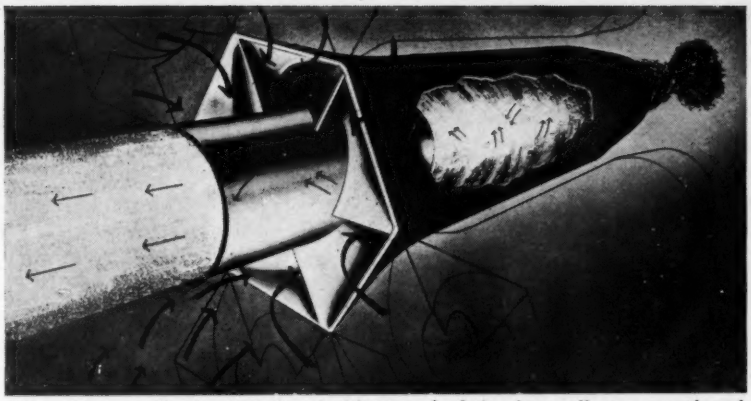
A pallet for bottles

A pallet of tubular metal, designed principally for bottles or cylinders of 9-in. diam., is available in four sizes holding 12, 16, 20 and 24 bottles. Manufactured by Weldon Industries Inc., it can be equipped with a chain or adjustable pipe retainer so that partly filled pallets can be handled safely. **CPE 1262**

Crushing

Gyratory crushers which do not employ *Babbit*, or anti-friction, metal for bearings, the complete mechanism relying on roller bearings throughout, are available for crushing ores, slag, limestone, etc., when these materials are reasonably dry and non-colloidal. Babbitless Co. (Great Britain) Ltd. say the mechanism consumes little lubricant, only a small addition of grease being necessary every three months. High rotational speeds are possible and, with a small degree of eccentricity, high capacity for any given size of machine results.

Unnecessary friction is suppressed and no cooling system for the lubricant is necessary. The mechanism of the *Babbitless* crusher is claimed to be dustproof and waterproof. A number of different models are available for primary, secondary or fine crushing. **CPE 1263**



Off to the moon? No, just the 'inside story' of the dust collector mentioned below, showing rotation and acceleration of gas.

Air gets a move on in new dust collector

The *SPA* dust-collection plant belongs to the multi-cellular group of dry centrifugals, but depends on a principle of selective particle acceleration. Thus, the makers claim, collection is extended to the smaller particle sizes, collector wear is eliminated and, despite the high collection performance, the pressure drop and power consumption are low.

The collector comprises a varying number of standard elements housed within a fabricated steel body with dust-collecting hopper. Each element comprises an inner and outer member assembled co-axially. The outer member is formed in two parts; an operating zone and a cylindrical collector tube welded together.

Dust-laden air enters the element over its hexagonal face at low velocity. The guide vanes immediately deflect it into a helical path and, as it passes through the nozzle, it is rapidly accelerated by the decreasing cross-sectional area. The air emerges from the operating zone at a velocity six times that at which it entered. It flows approximately two-thirds of the way down the collector tube before reversing up the central core of the vortex to leave the element through the inner member. The separated dust flows down the walls of the open-ended collector tube to the hopper beneath.

Efficiency figures of 80% at 5 microns and 93% at 10 microns, with dust having a specific gravity of 2, are claimed by the manufacturers, Steels Engineering Installations Ltd. **CPE 1264**

Gland treatment for pumps

When a large pump handling sewage effluent at a pumping station required an impeller renewal, the *Seatrist* T-Y gland was taken down. The gland had performed completely satisfactorily from the time it had been fitted—a total of three years eight months in service. A very low degree of wear was shown and it has been refitted to the pump for further service.

This is reported by the makers of the gland, Ronald Trist & Co. Ltd. In this type of gland the expendable component of the running faces may be removed in a matter of minutes and a new part fitted without stripping the pump. Where glands have been fitted to pumps handling an abrasive slurry, cost savings of about £15/pump/month have been reported, this amount having been previously spent on the repair or renewal of shafts or bearings. **CPE 1265**

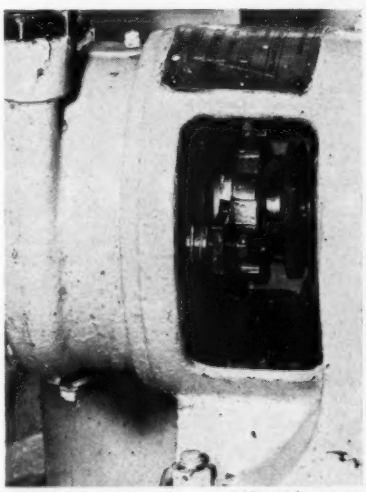
'Paint' turns to fireproof foam

A new, liquid surface coating, as easy to use as paint, is claimed to prevent flame spread and to delay 'flash-over' on combustible materials such as timber, fibre board, acoustic board, hardboard, etc.

When subjected to flames or the heat of fire, a foam barrier of a honeycomb structure is produced which acts as an automatic insulator. Suppliers are Exsud Engineering Ltd. **CPE 1266**

Hot work, but it refuses water

Kiln-car bearings, oven chains and conveyors, and other items located near ovens where temperatures reach 150°C. or more are amongst the applications for which *Microgel* grease is recommended by Shell-Mex & B.P. Ltd. This general-purpose grease repels water and is designed for use at temperatures higher than those at which conventional soap-base greases will operate satisfactorily. It incorporates a special gelling agent, with an inorganic base. **CPE 1267**



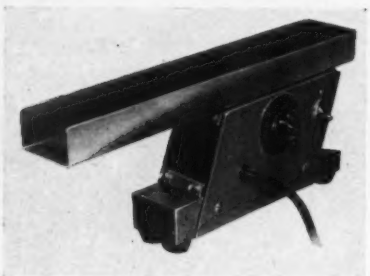
'T-Y' gland fitted to a Worthington-Simpson pump retaining hot fats.

Little feeder

A miniature magnetic vibratory feeder has been introduced which, by the turn of a control knob, can vary its output between 0 and 1,500 lb./hr. for a free-flowing material having a bulk density of about 100 lb./cu.ft. Manufactured by Sinex Engineering Co. Ltd., the unit allows for instantaneous cut-off in automatic weighing operations.

The feeder consists of a heavy cast base to which are attached two leaf springs supporting the feed trough. The trough, of stainless or mild steel, chromium-plated brass or plastic-coated steel, can be of any reasonable width and up to 12 in. long. An a.c. coil attracts and releases the trough, the assembly operating at its natural frequency of 3,000 cycles/min. Control is effected by a rheostat, an on/off switch also being fitted on the casing.

Dimensions of the casing, excluding the trough, are approximately 8 by $1\frac{3}{4}$ in. by 6 in. high. **CPE 1268**



Magnetic vibratory feeder.

Fill in and post the reply-paid card for details of any items in these pages, making sure to quote the correct 'CPE' reference number.

A 'sound' conveying system

A means of conveying materials pneumatically between different parts of a plant without having to provide a separate compressor for each blowing line is offered by a valve which, when installed in a blowing line, keeps the resistance of the line constant, irrespective of load. Developed by Henry Simon Ltd., it allows any number of valves to be powered from one compressor without interaction.

The valve consists of a convergent-divergent nozzle so proportioned that the air passing through reaches the velocity of sound. With a sonic valve interposed between a loaded line and the compressor, a pressure wave travelling towards the compressor as a result of a load change is halted at the valve throat, since the wave velocity of propagation is exactly equal to the opposing air velocity. In other words, the sonic valve introduces a sound barrier between the compressor and the varying line resistance. To overcome high-pressure loss a low-loss nozzle was developed.

The valve is made of aluminium, and is fitted with an adjustment by which the flow can be preset to any desired value. This avoids the need for a range of valves, and allows adjustment to be made to suit any future flow changes.

The Simon sonic conveying system is claimed to give lower initial and running costs, simplified maintenance and greater flexibility in dealing with variations in conveying rates. **CPE 1269**

★ *American Developments in Brief* ★

Active alumina of a new type in the form of spheres, of high sorptive capacity and mechanical strength, is available from Kaiser Aluminium & Chemical Corporation. Spheres range in diameter from $\frac{1}{8}$ to $\frac{1}{2}$ in. Principal constituents are eta alumina and alpha monohydrate, and the final product does not contain chi and gamma aluminas. **CPE 1270**

* * *

Porous carbon filter tubes suited to any type of tube filtering equipment are available with any internal or external machining from Union Carbide International Co. Typical configurations include plain open-end tube, blind-end tube, counter-bored tube, and blind-end tube with a collar flange. **CPE 1271**

* * *

The G. K. Porter flow rate calibrator offered by Brooks Rotameter Co. is a dry-seal, volumetric gas-collecting device used to calibrate flow-rate instruments with inert gases in the range 50 to 5,000 cu. cm./min. to accuracies within 0.2%. It consists of a portable panel housing three precision-bore, boro-silicate-glass calibrating chambers, back pressure indicator, gas temperature indicator, selector valves, automatic dump valve, precision timer, electronic timing control and automatic overrange protection. **CPE 1272**

* * *

A small-volume gas cell from Perkin-Elmer Corporation makes possible the obtaining of useful spectra with less than 0.02 c.c. of samples with normal absorption coefficients. The 7.5-cm. cell is ideally suited for the analysis of components eluted from gas chromatography instruments. Typical applications include the analysis of liquids that have appreciable vapour pressure at room temperatures, liquid petroleum gas, gasoline and organic solvents for purity determination. **CPE 1273**

* * *

An improved silica mortar, *Synar*, is being introduced by Pennsalt Chemicals Corporation. Based on an aqueous colloidal suspension of silica, it is inorganic and acid-resistant, used in the construction of masonry linings in acid containers of many kinds as well as in stacks and chemical process vessels. **CPE 1274**

* * *

A new process analyser for continuous operation, announced by Phoenix Precision Instrument Co., is based on the detection of refractive index differences between a process stream and a desired sample. A special recorder, based on a repeater principle, operates without batteries and standard cell. Various sensitivities are available combined with a special range-extension feature, allowing suppression up to 10 times the standard range without initial zero shift or change of reference solution. **CPE 1275**

* * *

Drums of tars, heavy oils, greases, paints, plastics and other products can be heated or melted with a two-piece drum heater from Glas-Col Apparatus Co. Inc. It consists of a roll-away base and a cylindrical portion, plus an insulated cover, all built of aluminium. Close spacing of heating coils provides uniform heat over the entire drum surface. **CPE 1276**

Improves flow metering

A new, high-performance diaphragm raises flow and liquid-level metering accuracies on the differential converter transmitters of Honeywell Controls Ltd.

The ' pneumatic balance ' differential converter, which previously contained a *Fluon*-coated diaphragm separating high- and low-pressure chambers, now uses *Viton* as a diaphragm coating which, say Honeywell, provides better long-term stability of measurement and higher stability under varying temperatures. It can be used to meter alkalis, amines, hydrocarbons, and dilute or concentrated mineral acids.

Teflon-coated diaphragm remains available for substances which might attack the new diaphragm. **CPE 1277**

Keeps electrolytes under control

The conductivity of electrolytes (*e.g.* steam condensate and heat-exchange media) can be automatically measured, indicated and recorded with the RIC3 instrument produced by Electronic Switchgear (London) Ltd. The overall dimensions have been reduced to the bare minimum that permits the use of a clearly legible chart and indicator of normal size.

The basic instrument is an automatically self-balancing a.c. measuring bridge employing as the measuring element a conductivity cell that isolates a specific volume of the electrolyte in which it is immersed. Variations of electrolytic conductivity cause the measuring bridge to become unbalanced; the resulting a.c. potential, which appears at the output of the bridge, is sensitively detected by an electronic amplifier. The output of the amplifier is applied to the ' signal ' winding of a double-wound induction motor. The phase of the amplified ' signal ' is determined by the sign of the conductivity change; and the phase relationship between the ' signal ' and a fixed reference a.c. potential, continuously applied to the second winding of the motor, determines the direction that the motor must rotate to drive the measuring bridge slidewire to restore balance.

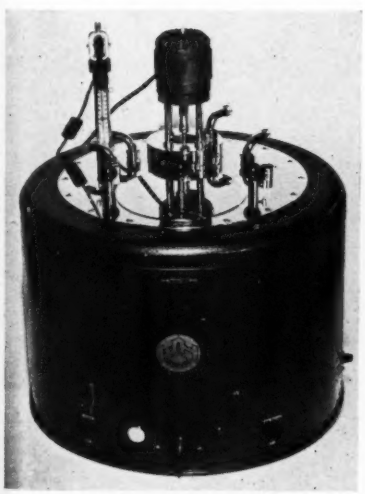
' RIC3 ' recorder for electrolytes.

The indicating dial and recording pen are mechanically coupled to the slidewire shaft; by such means they are caused to indicate and record the conductivity changes as they occur. **CPE 1278**

Goes hot and cold

Thermostat baths for temperatures of −50 to 300°C. are available with external circulation provided by a detachable pump. Temperature is controlled to ±0.01°C. by a mercury contact thermometer; electronic relays are available if required. The heat input can be preset in three incremental steps and an auxiliary heater provides accelerated heating up to the control temperature. The bath capacities vary from 2.5 to 40 l., the largest having five apertures to accept beakers or similar vessels up to 15 cm. diam.

The makers, Scientific Furnishings Ltd., say models are available with internal illumination and an observation window for U-tube viscometers. **CPE 1279**



Thermostat bath.

BP and petrochemicals

In spite of increasingly severe competition in petroleum chemicals, the three plants adjoining Grangemouth refinery of British Petroleum Co. Ltd., in which the company participates, operated at very satisfactory rates during the last quarter of 1958, according to the circulated statement of Sir Neville Gass, K.B.E., M.C. Sales of chemicals for that period were at the rate of 195,000 tons p.a.

In France, Naphtachimie S.A., in which the Société Francaise des Pétrôles BP has a substantial holding, increased its production of ethylene and ethylene oxide considerably and a new plant for the manufacture of polythene by the Ziegler process was commissioned. In Germany, Erdölchemic GmbH., in which BP Benzin und Petroleum A.G. has a half interest, has recently commissioned its Lurgi cracker and Linde gas separation plants at Dormagen.

In 1958 BP's total refinery throughput was just under 38 million tons, some 6 million more than in 1957. Construction work on the Kent refinery expansion project was completed at the end of the year and the new aviation gasoline plant was on full output in the fourth quarter of the year. At Grangemouth the new distillation unit, raising the refinery capacity to 3.2 million tons p.a., together with its ancillary plant, has been commissioned.

The new refinery in the Republic of Ireland at Whitegate, in which BP have an interest, has been completed and received its first cargo of crude oil. Construction work has started on the new refinery at Dinslaken in the Ruhr which is planned to be operating in the summer of 1960. At Kuwait the two new distillation units have operated efficiently, while at the Aden refinery throughput was 3,758,000 tons.

At Kwinana in Western Australia the throughput rose to 2,691,000 tons. The second catalytic reformer was commissioned in February 1959 and is now in operation. In Canada, work has started on the new Montreal refinery.

BRITISH STANDARD

Limestone for making colourless glasses (B.S. 3108, 1959, 4s. 6d.). Based on a specification of the Society of Glass Technology, this 15-page standard describes methods of chemical analysis and specifies limits for moisture content, chemical composition and size grading of limestone used in the manufacture of colourless glasses.

A quarterly summary of recent happenings in the United States

Who wants some uranium? The U.S. atomic energy programme has yielded a substantial annual tonnage of depleted uranium—material from which most of the fissionable U^{235} has been removed—in the form of uranium hexafluoride, and the Atomic Energy Commission has said industry can have it, if it wants it, for processing to the metal, oxide, or any desired compound.

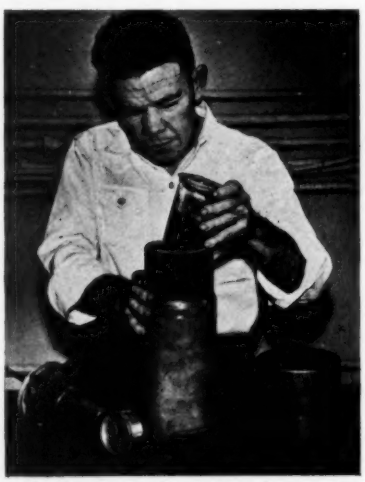
How much of it industry may use, and how, should be revealed shortly, for the Battelle Memorial Institute, Columbus, Ohio, is just completing a technical-economic survey of the subject that it has been conducting for the A.E.C. This study should bring forth some interesting ideas for putting depleted U to non-nuclear peaceful purposes.

Before World War 2, uranium and its compounds had a limited use in such applications as colouring agent for glass and glazes, as a component in some ferrous and non-ferrous alloys, and as a chemical agent in photographic films, negatives and prints. A maximum of about 100 tons p.a. was used for such purposes before war-time restrictions prohibiting such use were put in force. The Battelle research team will review the traditional industrial uses for depleted uranium and also, to get a more accurate picture of this material's future possibilities, will consider new or improved applications that may be brought forward by various laboratories in the U.S.A.

$

Current interest in ethylene oxide production means big business for plant contractors. This is reflected in the simultaneous start-up, by Scientific Design Co. Inc., of four different plants in three countries. Three of them went into operation during the same week and all four were put on stream within a 30-day period. The four plants are those of Jefferson Chemical Co. at Port Neches, Texas; Société Chimique des Dérives du Pétrôle, Antwerp, Belgium; Chemische Fabrik Holten GmbH., Ludwigshaven, Germany (a subsidiary of Badische Anilin- & Soda-Fabrik A.G., Ruhrchemie Aktiengesellschaft, and Th. Goldschmidt A.G.); and Erdoelchemie GmbH., Dormagen, Germany (subsidiary of Farbenfabriken Bayer A.G. and the British Petroleum Co. Ltd.). S.D. declare that plant performance in all cases was well in excess of guarantee figures, with yields hitherto unobtained in ethylene oxide experience. For one of the start-ups, the guarantee test was completed within 12 days after ethylene was first introduced into the plant.

The same company has received three further contracts for new ethylene oxide plants for Erdoelchemie, Société Chimique des Dérives du Pétrôle, and Naphtachimie, Lavera, France.



Molybdenum pentachloride being placed inside a steel bomb at the National Bureau of Standards.

Two new and convenient methods of preparing trichlorides and tetrachlorides of molybdenum have been developed by the U.S. National Bureau of Standards, partially supported by the U.S. Army's Springfield armoury. Both laboratory procedures involve reactions with molybdenum pentachloride, which is commercially available. Good yields are obtained under recommended temperature and pressure conditions.

As neither chloride can be obtained commercially, laboratory preparation is the only source of these compounds. The new development is claimed to have advantages over previous methods, in which, for example, the reaction between molybdenum pentachloride and hydrogen at a temperature of 250°C. and at atmospheric pressure gives a 5% yield of the trichloride after a period of 12 hr. With the improved method, lower temperatures and higher pressures are used, producing 97 to 98% yields of nearly pure material in 12 hr.

The present methods for both chlorides resulted from experimental studies conducted by D. E. Couch and A. Brenner of the Bureau staff. The trichloride was prepared by reducing the pentachloride with excess hydrogen. Ordinary high-pressure equipment, a 1-litre steel bomb, was used for batches of 50 to 500 g. Molybdenum pentachloride inside the bomb was treated with hydrogen at pressures from 100 to 1,750 p.s.i., while the bomb was heated in an external resistance-type furnace to temperatures ranging from 25 to 275°C. The trichloride was obtained in satisfactory yields as long as excess hydrogen was present; temperatures were between 125 and 194°C., and pressures were 100 p.s.i. and above.

The tetrachloride was prepared from a finely ground mixture of molybdenum trichloride and molybdenum

pentachloride. A glass tube containing about 5 g. of the mixture was sealed in an inert atmosphere and placed inside a steel bomb. Both were then heated in a furnace. A 2 : 1 mol ratio of pentachloride to trichloride gave the best results with respect to reaction time. At 250°C. the reaction was about 97% complete in 20 hr. The completeness of the reactions was determined by an assay for molybdenum trichloride based on its insolubility in 1 : 1 hydrochloric acid.

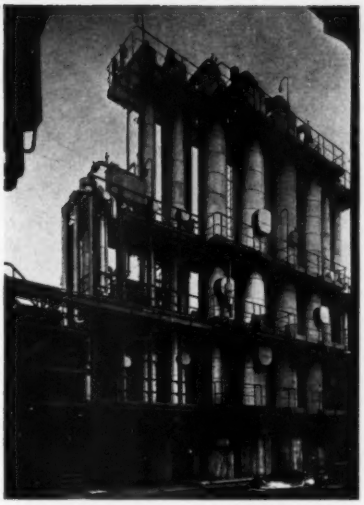
As chemical analysis of these compounds can be deceiving, *x*-ray diffraction patterns of various molybdenum chlorides prepared by other methods were compared with those of the trichlorides and tetrachlorides prepared as described above. The *x*-ray patterns of the trichloride prepared by hydrogen reduction and by thermal decomposition were identical. The patterns for the tetrachloride obtained from the trichloride-pentachloride reaction showed sharp peaks similar to those obtained with other pure samples of molybdenum tetrachloride. None of the peaks corresponded to those for lower- or higher-valent molybdenum chlorides. Thus the data confirmed the identity of the reaction products of the newly developed methods, indicating that these methods are satisfactory laboratory techniques.

$

Metallurgists and management in the chemical and petrochemical industries have learned in the past few years that many if not most of the leaks that develop in stainless-steel equipment used in those industries are stress-corrosion cracks. Most investigators in the field are agreed that stress-corrosion cracking is in part, at least, an electrochemical process. There is wide disagreement, however, as to just how much is electrochemical.

A stress-corrosion study of AZ31B magnesium alloy (aluminium 3%, zinc 1%) has recently been completed by H. L. Logan as part of a research programme sponsored by the Corrosion Research Council and the National Bureau of Standards. Indications from the work are that the inception and propagation of stress-corrosion cracking, in this alloy, are primarily an electrochemical process.

In most of the work, the specimen was placed in a cell and the corrodent was added before the stress was applied. It was found that, while the major strain occurred with the application of the stress to the specimen, the specimen continued to extend, but at a diminishing rate for a considerable time after the stress was applied. The



An American process (Scientific Design Co.) is used in this new ethylene plant of Chemische Fabrik Holten, Germany (see *opposite*).

calculations of many strain rates, determined for specimens stressed above, at, and below the threshold stress, showed that there was a critical strain rate, $500 \pm 100 \times 10^{-6}$ in./in./min. as determined 1 min. after the stress was applied. If this rate was exceeded, early failure by stress-corrosion cracking occurred and, if less, failure did not occur and the specimen showed little if any general corrosion.

It was found that there was a marked increase on the strain rate with the addition of the corrodent which suggested an explanation for the fact previously noted that most cracking and failures of specimens were found following rain.

It was possible to apply cathodic protection even after cracks had penetrated an appreciable distance into the metal, by polarising the entire specimen to the potential of the anodic areas. With its removal, the specimen was depolarised immediately and failure by stress-corrosion cracking occurred within minutes.

$

X-ray absorption, using the process of K-capture which generates *x*-rays as a result of the radioactive decay of an isotope source, has been used successfully for measuring ammonium chloride content in scrubbing tower wash water, and for determining calcium (sulphated ash) content in the manufacture of petroleum products.

Composition of the stream in regard to other constituents may or may not be important. Three cases readily handled are when all elements except the measured variable have small absorption coefficients for the radiation used; when there are elements of high absorption present, but their concentration is constant; and when two or more strong absorbers vary in constant ratio—this complex is the variable to be measured.

Mr. A. Beerbower, of Esso Research & Engineering Co., tells how a commercially available instrument, primarily designed for laboratory use, was redesigned to make it suitable for plant application, and used in three cases calling for continuous analysis.

$

When Atomics International needed a method for melting sodium for their test loops, used for the testing of large components and equipment, their engineers rose to the occasion by designing a unique mobile melting station which can be moved to pump liquid sodium into any facility reservoir. This was worked out so as to gain greater utilisation of a melting station, and to eliminate the necessity of having a stationary melting unit at each sodium test facility. This mobile design also resulted in significant cost reductions.

The unit can liquefy and pump 110 gal./hr. of sodium by means of two heaters that handle 55 gal. each in a completely dual system. The heaters may be used singularly or simultaneously depending upon the amount of sodium required for a test.

The all-electric console fixed on the portable station provides complete control of the melting system. Fifty-five-gallon drums of sodium are lowered into the heaters, which can maintain a temperature of 350°F. Nitrogen cover gas is maintained over the sodium level of the drums as the sodium is gravity fed to the transfer tank located beneath the heater platform.

The sodium is in turn forced up into the filter tanks and on to the receptacle, or reservoir, of the test loop by nitrogen pressure in the transfer tank. The tank, closed piping and filters are electrically heated to keep the sodium in a liquid state as it passes into the receiving reservoir.

$

A faster, more precise means for determining directly the sodium tripolyphosphate content and associated impurities in synthetic detergents has been worked out, using an ion-exchange chromatographic method with a difference. This should be welcomed by the synthetic detergent industry in which the exact composition of commercial STP has become increasingly important in the last few

years, and which has hitherto lacked a speedy, accurate method of analysis.

In work carried out in the laboratories of Monsanto Chemical Co. it was found that a major cause of poor precision in ion-exchange analyses is the erratic and incomplete recovery of the phosphate species from the column. This problem has been solved by reversing the flow of the eluant through the column and using an extremely fine-mesh, tightly packed resin bed. The pressurised, reverse-flow pattern works to prevent channelling and eliminates eluant convection currents in the resin bed. This is the key to complete recovery of each species from the column in its proper fraction.

A quantitative determination of the eluted phosphate species is made by an improved molybdenum blue colorimetric method. Only one fraction is collected and analysed for each species.

The complete composition of commercial STP is obtained and the procedure is claimed to be about twice as fast (1.33 man hours/sample) as paper chromatography. Four to six complete analyses can be made in 8 hr. when using four to six columns.

The method can also be used to analyse completely any mixture of low-molecular-weight phosphates including *ortho*, *pyro*, tripoly, tetra*meta* and tri*meta*. Further details were given by R. H. Kolloff in *A.S.T.M. Bulletin No.* 237, 1959, p. 74.

The Leonard Hill Technical Group—June

Articles appearing in some of our associate journals this month include:

Manufacturing Chemist—Rubber and Plastics in Chemical Plant; Hard Gelatine Capsules—How Eli Lilly Make 500 Million a Year; The Glycols, 1; Vetivert Oil from Reunion.

Automation Progress—Moisture Measurement and Automatic Control; Data Logging in Chemical Plant.

Petroleum—Gas Separation in Gasoline Processing—Russian Experiences; Electronic Instrumentation at Regent's Port Credit Refinery; Engineering Computer Control Systems; Pipeline Control Systems; Instrumentation in the Petroleum Industry.

Paint Manufacture — Oil and Colour Chemists' Association Biennial Conference; Colloid Mills for Paint Manufacture; Mechanical Handling Can Cut Costs.

Atomic World—Impact of Atomic Energy on Analytical Chemistry; Radiochemical Analysis for Non-active Gases; Nuclear Energy in Norway; Chapelcross Nuclear Power Station.

Corrosion Technology—Plastics Against Corrosion.

INDUSTRY REPORTS . . .

Chemical manufacture in three countries

Capital expenditure by the Albright & Wilson Group in 1958 amounted to £3.1 million, compared with just over £2 million in the previous year. In Britain, expenditure was spread over a relatively large number of projects. New plants for phosphorus pentasulphide and for several organic phosphorus compounds were completed and further extensions were made to oil additives production capacity, while among the items on which work was commenced during the year were new pilot-plant facilities at Barry and an enlargement of the research laboratories at Oldbury. The most important overseas project was the expansion of the Canadian subsidiary's capacity for the manufacture of sodium chlorate. In Australia, a new phosphorus furnace was brought into operation, and a plant was built to make sulphonates that had previously been supplied from England. Altogether, in 1958, £1.2 million was spent in Britain and £1.9 million overseas.

These facts were given by Mr. S. Barratt in his statement for the year. It was also noted that the company have discontinued, after 25 years, the manufacture of phosphorus at Widnes, requirements being met from plants at Oldbury and Portishead.

Speaking of subsidiary companies, the chairman said that the extension of the plant of Solway Chemicals Ltd. will increase the output of sulphuric acid and cement 50% by 1961. Midland Silicones Ltd., to promote further growth in capacity of silicone production, is investing in larger pilot-plant and product development facilities, with an increase in technical staff.

The much-enlarged sodium chlorate manufacturing plant of Electric Reduction Co. of Canada Ltd., at Buckingham, Quebec, was used to maximum capacity after mid-year completion. Capacity at Vancouver and Buckingham is now sufficient to meet Canada's needs for some time to come. Major developments are taking place at Port Maitland, Ontario, where plants are being built to make phosphoric acid, sodium phosphates and other chemicals. The project will cost about £4 million and production will begin in 1960.

Both turnover and profit of the Groups were the highest recorded, even though trading conditions for the year had been irregular and often disappointing.

Petrochemicals and plastics in Italy

Determination to continue development of the company's petrochemical activities was expressed at the annual meeting of Montecatini (Italy) by the chairman, Dr. C. Faina. The company has seven petrochemical plants either in operation or under construction and recently the first stone was laid of the large works at Brindisi which will be built in a little less than three years. A new and imposing formaldehyde plant is to be built at Castellanza and there will also be an increase in the productive capacity of ethylene derivatives. Polypropylene production facilities at Ferrara are being extended and a second polypropylene plant will be erected at Brindisi.

Montecatini's production of pyrites reached 1,364,000 tons in 1958, while the company's various nitrogen plants operated maximum capacity despite the unfavourable international and home market situation. At Campo Franco, Sicily, a plant for the production of potassium salts is being erected.

£ s d

CHEMICAL PLANT COSTS

Cost indices for the month of April 1959 are as for March:

Plant Construction Index: 180.0

Equipment Cost Index: 165.2

(June 1949 = 100)

£ s d

New fields for electrostatic precipitation?

Development work aimed at providing design and data for both new and old products has achieved some marked success with mechanical gas cleaners and highly efficient fans, Mr. H. W. Wagner, chairman of Sturtevant Engineering Co. Ltd., revealed in his annual statement. He said that several projects now in hand, dealing with chemical engineering processes, and others would in time add completely

new products to the Sturtevant range.

In common with most other British companies Sturtevant were faced with a falling-off of orders during many months of 1958; despite this, the group profit came out at only £2,600 lower than the previous year.

Mr. Wagner pointed out that the reduction in the number of coal-fired power stations now being built in the U.K. was bound to affect the volume of orders received by the electrostatic precipitation department, but every effort is being made to compensate for this by obtaining contracts from overseas and also to open new fields at home for the use of this equipment.

Aluminium operations

All the jointly owned primary aluminium facilities of Ormet Corporation (U.S.A.) are now in full operation, it was reported at the annual meeting. The fifth and last potline of the reduction plant began production in January and the third and final electric generating unit in March. The aluminium plant is now producing at better-than-projected capacity and further lowering of production costs is expected.

Completion is proceeding on schedule of the new paper machine at Pisgah Forest, N.C., the chemical plants in Joliet, Ill., the government-owned high-energy fuels plant at Model City, N.Y., and other facilities.

New nickel refinery

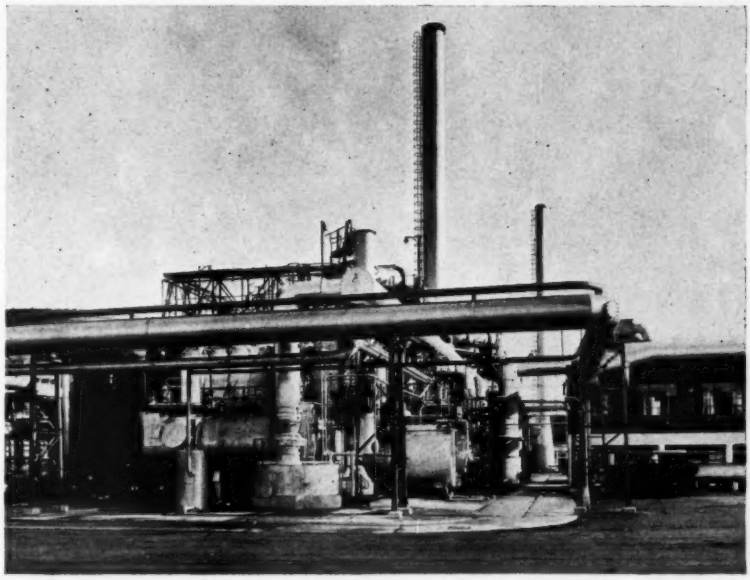
An electrolytic nickel refinery with a capacity of up to 75 million lb. p.a. is to be built at Thompson, Manitoba, by the International Nickel Co. of Canada Ltd., said Dr. J. F. Thompson, chairman, at the annual general meeting in Toronto.

The refining process to be employed was developed within the company. A main feature is the direct electrolysis of nickel matte, which eliminates high-temperature oxidation and reduction operations. Nickel sulphide of low copper content from Bessemer converters will be cast directly into sulphide anodes and electrolysed for the production of high-quality nickel. The completion of the Manitoba project will increase the company's total annual nickel production capacity to 385 million lb. beginning in 1961.

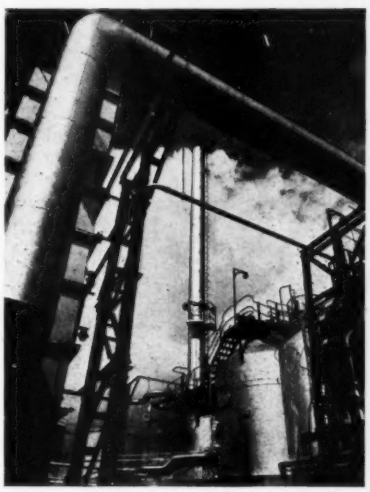
The chairman also announced that the company started using natural gas instead of oil as a fuel in the multi-hearth concentrate roasters in the Copper Cliff, Ontario, smelter. Provision has been made for delivery of up to 10 million cu.ft./day of this fuel since the recent completion of the pipeline from Western Canada.

Refinery-gas Reforming in Essex

(*Some pictures of the Romford plant, described on page* 193)



General view of the catalytic oil-gas plant, showing 24-in. main.



Seen in this group at the Romford oil-gas plant during the recent visit of the Minister of Power are (*left to right*)**: Dr. J. Burns, Chief Engineer of the N.T.G.B.; the Mayor of Romford and behind him, Sir Harold Smith, Chairman, Gas Council; Mr. M. Milne-Watson, Chairman, N.T.G.B.; Lord Mills, Minister of Power; Mr. E. R. Stewart, Station Engineer, Romford.** ▶

◀ **This view of the plant shows** (*right*) **two of the O.N.I.A.—G.E.G.I. catalytic reactors and the associated stack.**

Flash evaporator of a new type for producing high-purity distilled water from sea-water with uninterrupted operation at high output is described in a booklet issued by Richardsons, Westgarth & Co. Ltd., Northumberland Engine Works, Wallsend, Northumberland. With the aid of flow charts the essentials of the design, scale formation and feed treatment, moisture treatment, etc., are dealt with. Another section views the evaporator as part of an integrated heat utilisation scheme.

Technology Notebook

Distillation course

A summer school on 'Distillation Techniques' will be held in the Department of Chemical Engineering, Loughborough College of Technology, from July 21 to July 30 inclusive. This course, which will cover the major design techniques in the field of distillation up to or beyond the level of the usual undergraduate honours course, is intended for persons with a degree or similar qualification in a pure or applied science and who have some industrial experience in the field of process engineering.

The syllabus includes lectures on 'Equilibria and Thermodynamics,' 'Stagewise Calculations' and 'Plant Design.' Further information is available from the Registrar, Loughborough College of Technology, Loughborough, Leics.

Corrosion

A summer school on 'Newer Materials for Resistance to Corrosion' will be held in the Metallurgy Department, Battersea College of Technology, London, from September 28 to October 2 inclusive. The lectures will deal with metallic and non-metallic materials resistant to aqueous and high-temperature corrosion. The topics will include design in corrosion, nickel alloys, stainless steels, titanium, zirconium, tantalum, precious metals, plastics and coatings of plastics, fibreglass, paints, etc.

Fee for the course is £12 12s. and application should be made to the Secretary (Summer School), Battersea College of Technology, Battersea Park Road, London, S.W.11.

Cryogenic engineering

Engineering research and development at very low temperatures will be discussed at the 1959 Cryogenic Engineering Conference, to be held at the University of California, U.S.A., on September 2, 3 and 4. Information from: The Secretary, Cryogenic Engineering Conference, Chemical Engineering Department, University of Colorado, Boulder, Colorado, U.S.A.

Lectures on materials handling

Drawing attention to the need for a scientific and informed approach to materials handling problems, the National Joint Committee on Materials Handling offers to assist secretaries of societies and other bodies drawing up their programmes for the 1959-60 sessions by suggesting suitable subjects for lectures and possible lecturers. Enquiries should be addressed to the secretary of the organisation at 69 Cannon Street, London, E.C.4.

Mechanical engineering research

The Council for Scientific and Industrial Research announces that in future the Mechanical Engineering Research Laboratory at East Kilbride, near Glasgow, will be known as the National Engineering Laboratory. The Council considers it desirable to emphasise the national character of the laboratory which is part of the D.S.I.R. organisation and is financed from public funds. It does not imply any change in the field covered by the laboratory, which will continue to be concerned with problems of mechanical engineering.

The Council has also decided to set up a steering committee to look after the programme of the laboratory.

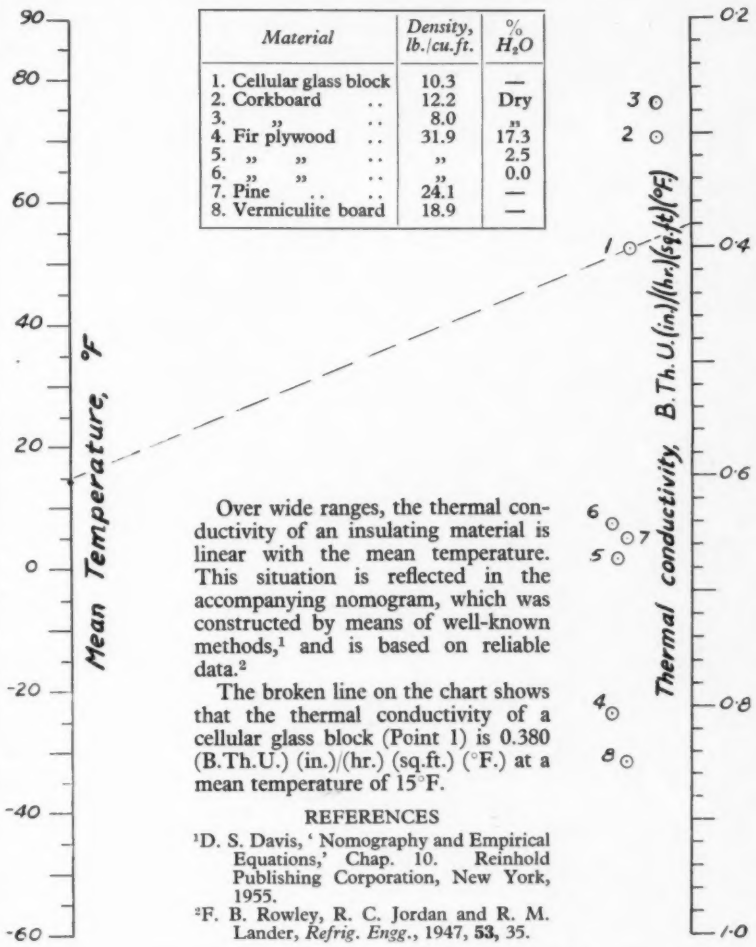
NOMOGRAM:

Thermal Conductivity of Insulating Materials

By D. S. Davis

(Head, Department of Pulp and Paper Technology, University of Alabama)

Material	Density, lb./cu.ft.	% H_2O
1. Cellular glass block	10.3	—
2. Corkboard ..	12.2	Dry
3. „ ..	8.0	„
4. Fir plywood ..	31.9	17.3
5. „ „ ..	„	2.5
6. „ „ ..	„	0.0
7. Pine	24.1	—
8. Vermiculite board	18.9	—



Over wide ranges, the thermal conductivity of an insulating material is linear with the mean temperature. This situation is reflected in the accompanying nomogram, which was constructed by means of well-known methods,[1] and is based on reliable data.[2]

The broken line on the chart shows that the thermal conductivity of a cellular glass block (Point 1) is 0.380 (B.Th.U.) (in.)/(hr.) (sq.ft.) (°F.) at a mean temperature of 15°F.

REFERENCES

[1] D. S. Davis, 'Nomography and Empirical Equations,' Chap. 10. Reinhold Publishing Corporation, New York, 1955.

[2] F. B. Rowley, R. C. Jordan and R. M. Lander, *Refrig. Engg.*, 1947, **53**, 35.

World News

PAKISTAN

Brine discovered

Large deposits of hot concentrated brine, similar to Michigan brine, are officially reported to have been discovered at Dhariala in the Jhelum district. The brine occurs at high pressure and with a capacity flow of 60,000 gal./hr. The Government are anxious to develop this source of chemicals, *e.g.* potash, and have offered to extend all possible help to interested industrialists and chemical manufacturers.

INDIA

New dyestuffs plant

A major extension to the vat dyestuffs plant of Atic Industries Private Ltd. at Bulsar, Bombay, was opened recently. The company is a joint enterprise of Imperial Chemical Industries (India) Private Ltd. and Atul Products Ltd.

Polythene production

India's first full-scale polythene plant, built by Alkali & Chemical Corporation of India, a subsidiary company of I.C.I. (India) Private Ltd., was opened recently. Including houses, roads and services, the project has cost approximately £3 million.

The new plant has a capacity of 3,500 tons of *Alkathene* (I.C.I. polythene) which it will produce by I.C.I.'s high-pressure process. The main raw material is ethyl alcohol, produced by distilleries from molasses. The alcohol is dehydrated in a converter to produce ethylene, and this gas is purified before being compressed and polymerised.

Indian chemists, chemical engineers and other engineers have been trained in Britain and Australia to take their part in running the plant. Technical experts from I.C.I. plastics division have been in India since February to assist and advise in the commissioning of the plant.

Superphosphate factory

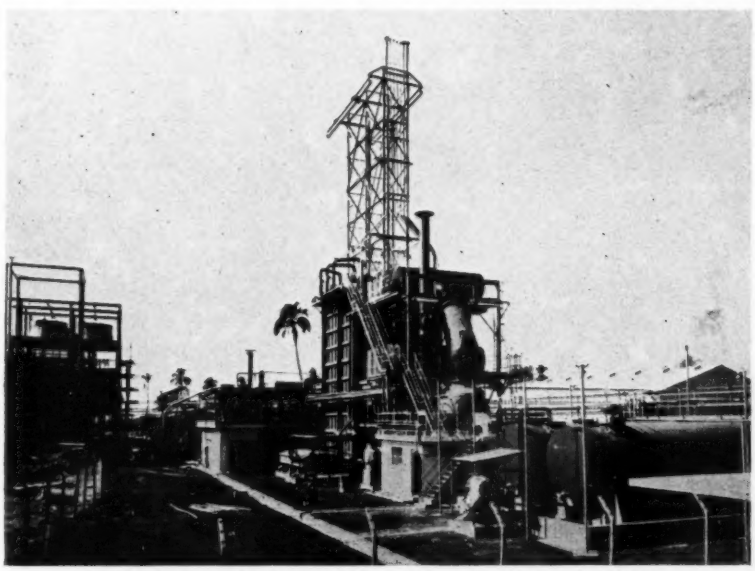
The Bihar Government's first State-owned industrial project, a superphosphate factory at Sindri, has an initial capacity of 18,000 tons p.a. This will be raised to 65,000 tons by the end of 1961. India's total output of superphosphates was 181,000 tons in 1958 compared with 81,000 tons in 1956.

HUNGARY

Chemical and fertiliser projects

At the Tiszapalkonya Chemical Combine work is to start this year on an artificial fertiliser factory which will have an annual output of 210,000 tons by 1964. This is in addition to a natural-gas works and a lacquer and artificial-resin factory already scheduled for the Combine.

Meanwhile the Borsod Chemical Combine is to be expanded so as to raise production 30% by 1960. Also included in the new industrial investment plans is a chemical machinery plant which will be built at the Láng machine factory in Budapest, at a cost of £600,000.



Polythene production in India—a view of the converter unit

NETHERLANDS

Extension to synthetic glycerine plant

Shell Pernis Chemische Fabrieken N.V. announces that the capacity of the synthetic glycerine plant at Pernis (Rotterdam) will be increased. As a first stage in the expansion programme the capacity will be increased to a minimum of 15,000 tons p.a. The production from the increased capacity is expected to become available early in 1960.

The decision to increase capacity has been taken within a year of the commissioning of the original plant.

COLOMBIA

Caustic soda plant

A new plant, supplied from Italy, for the production of caustic soda has been added to the plant associated with the ancient salt mines at Zipaquira, and its production will enable Colombia to meet all its requirements of caustic soda from home production.

RHODESIA AND NYASALAND

Copper exploitation

The Messina Transvaal Development Co. Ltd. is to subscribe £600,000 and M.T.D. (Mangula) £150,000 as initial capital for the Messina Rhodesia Smelting & Refining Co. which will establish a copper mine and smelting and refining plant at Alaska, about 70 miles from Salisbury. The new mine is expected to produce initially about 500 long tons/day of ore; this ore and ore from other mines in Southern Rhodesia will be treated at the new smelter.

FINLAND

Atomic reactor for Norway

It is reported that the Finnish Atomic Energy Commission and its Norwegian counterpart have agreed on Finnish participation in the construction of a research reactor which is to produce heat for a paper mill at Halden in Norway. Finland is to provide engineers and technicians.

AUSTRIA

Oil refinery trouble

Refineries were recently reported to be having difficulties with the first deliveries of the half million tons of oil sent by the U.S.S.R. following last year's agreement with the Austrian Government. This Soviet oil has a high salt and sulphur content and

has corroded the Austrian refineries which are adapted to very low sulphur content. Certain alterations to the refineries are therefore necessary. Furthermore, Soviet oil has a high petrol content (27 to 30%) but of a low-octane value. It is reported that these difficulties have led to a reduction of refinery throughput and higher production costs.

INDONESIA

Fertiliser plant

Plans to construct a fertiliser plant at Palembang, south-east Sumatra, have been agreed between the Indonesian Government and the Standard Vacuum Oil Co. under which the latter will supply natural gas to the plant. The urea fertiliser plant, which is to be built with the aid of a $U.S.30-million Eximbank loan, will be capable of producing 100,000 tons p.a., equivalent to 200,000 tons of Z.A. fertiliser, and will use natural gas as the main raw material.

POLAND

Streptomycin

Work is proceeding at Tarczomin factory on the construction of plant for manufacturing streptomycin. About 10 tons should be manufactured in 1959-60 and full output, 20 to 25 tons p.a., should be reached by 1961-62.

ARGENTINE

Petrochemical plants

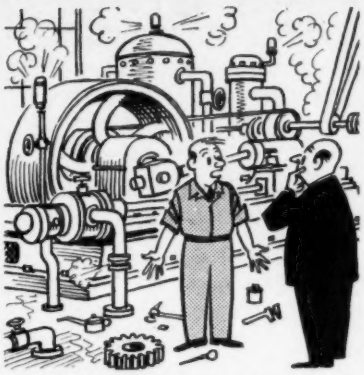
A United States company, Texas Butadiene & Chemical Corporation, has submitted proposals for the establishment of two petrochemical plants in the oil production region of Comodoro Rivadavia in Patagonia. The proposed factories will produce lampblack and raw materials for the manufacture of synthetic rubber. The associate of another United States company (Koppers International) is negotiating with the Government for the erection of another synthetic rubber plant.

SOUTH VIETNAM

Paper factory

Arrangements are said to have been completed between the American firm, Parsons & Whittemore, and the Vietnamese Government for the establishment of a paper factory near Saigon. The mill, which will use pine wood as a raw material, is expected to have a capacity of 10,000 tons p.a. of paper and will cost some $U.S.4 million.

Comical Engineering Corner



'If only I could find the washer for the adjusting screw, I could put it right.'

Personal Paragraphs

★ **Mr. D. M. Boyd,** a director of Fisons Ltd., has been elected chairman of the Association of Chemical and Allied Employers. He succeeds **Sir Laurence Merriam,** who retires after a two-year term of office. Mr. Boyd has relinquished his duties as production director of the fertiliser division of Fisons in order to devote himself fully to the new appointment. He will remain a member of the fertiliser division's board and will continue as a director on the main board of Fisons.

★ **Mr. W. P. Fletcher** has been named manager of the new elastomers research laboratory just completed by the Du Pont Co. (United Kingdom) Ltd. at Hemel Hempstead. He was responsible for a number of new physical testing developments while associated with the British Rubber Producers Research Association from 1947 to 1958. While with the Association he supervised its investigation work on problems relating to industrial uses of dry rubber products.

★ **Mr. R. S. Hewitt** has joined the board of Elliott Bros. (London) Ltd. He started his career with the company in 1928 and is deputy controller of Elliott-Automation.

★ **The Rt. Hon. The Earl of Halsbury** has joined the board of Head Wrightson Processes Ltd., Head Wrightson & Co. Ltd. announce.

★ At the annual general meeting of the Association of British Ebonite Manufacturers, **Mr. A. W. Hopkins,** of the General Electric Co. Ltd., was re-elected chairman for 1959-60.

★ **Mr. P. T. E. Lake** has been appointed technical sales respresentative of Nordac Ltd. in the north-east of England.

★ **Mr. J. C. Marshall** becomes southern district manager to the chemicals division of Union Carbide Ltd.

★ **Mr. C. L. Boltz** has been appointed science correspondent in the B.B.C. news division (sound and television). This is the first appointment of its kind in Britain. He has been science correspondent of the B.B.C. European Service since 1952 and has made many hundreds of broadcasts on all aspects of British science and industry.

★ **Mr. W. H. Heydon** has been appointed to the board of William Press & Son Ltd. He joined the company in 1941 and has for many years held the position of chief engineer.

★ **Mr. D. E. Cameron** of the B.B. Chemical Co. Ltd. has been elected chairman of the British Rubber and Resin Adhesive Manufacturers' Association for 1959-60; **Mr. N. G. Bassett Smith,** Dunlop Rubber Co. Ltd., becomes vice-chairman.

★ **Mr. R. O. Richards** has been appointed chief engineer, design and development department, Woodall-Duckham Construction Co. Ltd., in succession to **Mr. F. S. Townend,** who has retired after 36 years' service. Mr. Townend has been appointed a consultant to the company.

★ **Dr. W. Steven,** superintendent of the development and research department laboratory of the Mond Nickel Co. Ltd. in Birmingham, is being transferred to the development and research division of the International Nickel Co. Inc., New York, as director of research. He has also been elected an assistant vice-president of that company. **Dr. G. L. J. Bailey** succeeds him as superintendent of the Birmingham laboratory, while **Dr. W. Betteridge** has been appointed superintendent of the platinum metals research laboratory, Acton.

★ Sharples Centrifuges Ltd. announce the appointment of **Mr. E. C. C. Harvey** as senior project engineer responsible for the company's activities in south-east England. Before joining Sharples he was with the British Petroleum Co. Ltd. at their Abadan refinery and more recently with Shell Mex B.P.